

DISCOVERY

A Monthly Popular Journal of Knowledge

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AN EMINENT FIELD NATURALIST

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Editorial Notes.

ONE of the greatest difficulties afflicting nearly all branches of science is the astonishing complexity introduced by the great amount of individual work buried in past and present papers. It may be an obscure chemical compound, an odd electrical effect, or a rare or new form of microscopic animal. Facts are wanted. Above all the student wants to know what work has previously been done on the subject, and where he can find the record. It is not always easy to know even where to look for any previous work. Classification has not been very precise, and the needed facts may be buried in the journal or proceedings of some quite unlikely society. In order to make the search more interesting somebody consulted says "I have an idea that some work on this was done a year or two before the war by a German. I seem to remember something about it." Later someone else suggests that it was not a German paper but a Swiss one from Geneva. Eventually nothing can be traced. A lot of hard work is then put in on the subject by the student, and when his paper appears somebody writes from Prague to point out a priority claim on behalf of work done years ago by a well-known Czecho-Slovak who was at that time a Russian. The pressing need of the time is for some adequate system of filing or co-ordination which will regulate the mass of promiscuous facts already got together and register fresh contributions to knowledge under proper headings.

Filing and organization were developed to a high and important art in the various temporary ministries of war, but the task of co-ordinating the increasing mass of scientific facts of all kinds would seem to be a far greater enterprise than any little bit of office work accomplished by a wartime organization. It would make a very pleasant little memorial for some multi-millionaire. He could endow an Institute for Sorting Facts so that the inquirer could just walk in and put up his query. In about half an hour an attendant would bring back a folder containing references to everything in the way of original work which had been published on the subject anywhere. It does not sound quite so impossible as it really is. But when you consider that there is no subject-index to the British Museum Library you get some vague kind of idea of the enormous amount of work involved in an endeavour which would have to cover not only printed books but an almost infinite range of journals.

* * * * *

The Prince of Wales is to be President of the British Association for the Advancement of Scientific Knowledge next year. A sound Victorian precedent has been found in the Prince Consort, but I think we might have gone back even further and found perhaps a more exciting royal predecessor in Prince Rupert, who contributed a variety of entertaining interests to the Royal Society in its earliest days. He had not only an inquiring mind but a very clear idea of the practical application of scientific knowledge in the particular branches now popular at Woolwich. Gunpowder and powder-testing figure very largely in the early records of the society. They were mightily interested in *Aurum Fulminans*, and apparently carried out some ingenious experiments which we should be rather frightened of to-day. Why they failed to blow themselves up is not to be discovered from contemporary records like Birch's History of the Royal Society. It looks rather as if they were saved from calamity by the fact that chlorate of potassium, which we now use with fulminate, was not discovered till half a century later. Otherwise Prince Rupert

and Sir Robert Moray might have modified the whole course of scientific progress. Who can guess how long progress might have been delayed if the mighty brain of Sir Isaac Newton had been shattered by a bomb experiment.

* * * * *

It was while looking through those early records for particulars of a curious firearm of the seventeenth century that I came across a note which is of some interest in the history of inventions. The basic principle of an automatic firearm or a recoil or gas-pressure operated machine-gun has always been looked on as a late nineteenth-century invention nursed to success by Sir Hiram Maxim. Yet in 1663-4 it is recorded that an ingenious mechanic came to Prince Rupert with an odd weapon in which the strength of the fire that was in the powder was used to allow it to go on loading and firing itself so long as the trigger was held back. There seems to be no further record of the invention, and it is doubtful if any automatic arm could have worked even moderately safely before the evolution of the percussion system and the development of the metallic cartridge, but it might—just might—have led to machine-guns of a sort at Ramillies and Malplaquet. Well, taking it all round, perhaps the Prince Consort and the British Association is a safer precedent than Prince Rupert and the Royal Society.

* * * * *

The problem of who reads *Discovery* is always rather a mystery, but it is rather cheering to find that Sir Oliver Lodge, F.R.S., reads it. An article by Mr. Vibert Douglas of McGill University on "Measuring the Universe," which appeared in our number of September last year, has brought about correspondence between Sir Oliver Lodge, Mr. Vibert Douglas and Dr. Silberstein on some point which is far too abstruse for us to comprehend. On the other side there is the reader who wrote: "I buy *Discovery* regularly, rather against my own will. Why don't you get easier articles? A lot of your articles are not too easy to understand and make one think." This is deplorable and possibly dangerous, but even if our correspondent's appreciation of psychology is a bit haphazard, his complaint is something of a compliment. We do not propose to give you articles that you cannot understand, but on the other hand, if the subject is a bit difficult and actually makes you think, it is not altogether to the bad. It is perhaps an unusual feature in a paper. Most papers rather make a point of printing nothing that a housemaid cannot understand. *Discovery*, on the other hand, assumes a certain amount

of intelligence on the part of its readers and, judging by the increasing circulation, this progressive attitude is justified. We have our troubles and we need help in the shape of more readers, but I should be far more seriously disturbed if a large number of people complained that the paper failed to make them think.

* * * * *

Have you a skull you have no use for? This has nothing to do with the preceding paragraph, but is a bald introduction to a demand for a few heads. I do not want them for myself, but the Secretary of the Royal Anthropological Society has unofficially betrayed the fact that disused crania are badly wanted. The society will, I gather, welcome not just ordinary skulls of unknown origin, but skulls of different races. There must be many overseas readers of *Discovery* who could send in skulls of native races from all parts of the world and who would thereby be contributing very useful material for ethnological study. If this note happens to meet the eye of anyone with possible specimens we will be glad to receive them and hand them on to the society.

SOCIETY OF CHEMICAL INDUSTRY.

(President, W. J. U. Woolcock, C.B.E. London Section: Chairman, Bernard Dyer, F.I.C., Central House, Finsbury Square, E.C.2.)

THE annual meeting of the London Section for the election of members of committee will take place on 8th June. Below is a list of the present committee, the names of those who retire under Rule 7 and are ineligible for re-election being indicated by an asterisk. Nominations to fill these vacancies, each signed by not less than five members of the Section, should be sent in so as to reach the Hon. Secretary not later than Friday, 1st May.

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COMMON COLDS.

If you are suffering from a cold be comforted. Science declares that the average person suffers from 3.7 colds per year. October and January are the worst months.

On Sea Anemones.

By T. A. Stephenson, D.Sc.

(Zoology Department, University College, London).

Facts are needed about our British sea anemones. The author of this article will be glad of the help of readers of Discovery who may be able to send in live specimens for study. A certain elementary knowledge of zoology is desirable, and it is possible that schools or local natural history societies could co-operate usefully.

SEA anemones are a group of animals very widespread in the world, but of recent years they have not been very extensively studied by zoologists, and there is much about them of general interest which still awaits discovery.

The following details will give some idea of their range. They occur in all parts of the world; on shore, on coral reefs, in ocean depths, or even floating freely at the surface of the sea. Most usually they attach themselves to stones or other fixed objects, but some frequent sandy spots where they burrow, worm-like, and bury themselves almost completely, only the head end remaining above ground. Although generally fixed to other objects, they are most of them able to move about quite freely, though slowly, creeping slug-wise or using their tentacles as feet. They reach their largest size and most elaborate form and colour in warm seas (anemones two feet across being known from such places), but their range extends nearly to the poles. The "Challenger" dredged anemones from such depths as 2,900 fathoms (over three miles), and Captain Scott's "Terra Nova" expedition brought them back from McMurdo Sound, not far from the South Polar ice-barrier.

Early Studies.

Anemones and their relations have been known to naturalists for hundreds of years. Aristotle recognized their animal nature, but to early writers in general they or their kindred were half-and-half creatures, partly plant and partly animal, or even partly plant and partly mineral; and it was not realized for some time that they are purely and entirely animals, although they look very like flowers under favourable conditions. This realization came sooner, generally speaking, for the anemones themselves than for some of their skeleton-making neighbours. Since early days scores of naturalists have studied and written about them, including Linnæus, Lamarck, Cuvier, and other well-known workers. But the thorough understanding of them began in 1860, with a book on the British sea anemones by Philip Henry Gosse (father of Edmund Gosse), and since then our knowledge has developed rapidly.

A typical anemone has a cylindrical body fixed by its base to a firm support, and with a mouth in the centre of the other end of the cylinder. The oral end of the cylinder is bordered by several concentric rings of adhesive tentacles. From the mouth a short flattened tube leads into the interior of the animal; the interior being a single cavity sub-divided incompletely into alcoves by a series of vertically placed radiating partitions of skin, which bear muscles and sexual and digestive organs.

Stinging Anemones.

The stinging powers of medusae are well known, but those of anemones less well. Their stinging powers are less great than those of medusae, and only a few kinds do it seriously, from the point of view of mankind; but even some of our English species can sting certain individuals, though leaving others unhurt. The normal use of the stinging is for the capture of food. The food consists of almost anything the anemone can catch with its tentacles—small fish, worms, shrimps, periwinkles, crabs, etc., etc.; and the struggles of the prey are countered by stinging it into a comparatively quiescent condition. When it is quiet enough, the anemone opens its mouth and gradually swallows the food; the latter is digested inside, and any indigestible refuse rejected through the mouth. Sometimes the object chosen for swallowing is too large to be conveniently dealt with—an anemone has even been known to virtually cut itself in half by swallowing a flat shell too big for it, which made a partition across the middle. They can manage to engulf prickly food, such as sea-urchins, without much difficulty. But apart from these obvious sources of food, they appear to feed also on the creatures of microscopic size which abound in sea-water.

It is not known exactly how long an anemone lives, but evidently for a very long time. There are now living a number of specimens of *Cereus pedunculatus* which have been in an aquarium for more than sixty years; they are still in excellent health, and look as young as ever; but they produce fewer young ones as they grow older.

Young anemones develop from eggs, like the young of all but the lowest animals, and some of them attain maturity very soon—e.g., in fifteen months. This method of reproduction is common to them all, but in certain cases it is supplemented by one or more asexual modes. The commonest of these is for a small fragment of the edge of an anemone's base to become separated from the parent and to form a new individual; but sometimes the original animal divides vertically into two more or less equal parts.

Edible Species.

On the whole, anemones appear to be comparatively free from enemies. It is true that certain fish can and do tackle them, but to many their stinging properties must render them unpalatable. Cod, for instance, eat sand-burrowing and other anemones, so do flat-fish; and anemones have been used regularly as bait in some places. Other enemies are sea-slugs and sea-spiders. Some species of sea-slugs can gnaw away at them, disregarding the stinging apparatus altogether, swallowing with their meal the small capsules contained in the tissues of their prey, which produce the sting. The capsules, once inside the slug, may find their way into its skin, there to serve

a similar purpose to that which they once served in the anemone. Sea-spiders have a proboscis which they dig into the anemone, feeding on its tissues in this way; and evidently they are able to injure, or even eventually to kill their victim, in some cases at any rate. Some kinds of anemones have been, and still are, used as human food, but not very extensively. For instance, Maoris have been known to eat a large New Zealand species (*Cradactis magna*) at times when other food was scarce. When cooked, they taste like oysters. Parasites affecting anemones are not often recorded, but they are known, and belong to several animal groups—worms, protozoa, crustacea.

Certain very interesting anemones are associated during part or most of their lives with other animals. Some larval forms (e.g., *Peachia*) attach themselves,

early on, to small medusae, which carry them about for a time. Eventually the anemone grows large, and probably eats the medusa, and then settles down on the sea-floor, takes to burrowing, and grows up as a sand-dweller. In another case a crab (*Melia tessellata*) inhabiting the Hawaiian Islands and other regions, takes up an anemone in each claw and goes about with it, using the anemones after the manner of boxing-gloves, holding them up in a defensive attitude when alarmed, and also stealing from the anemone much of the food which it captures. The crab seems to be dependent upon the anemone, but the anemone is not dependent on the crab; and the status

of the former would appear to be one of servitude rather than of partnership. In other cases, more commonly met with, an anemone lives on a shell which is inhabited by a hermit-crab, as in the case of *Adamsia* and *Eupagurus*; and here there does seem to be partnership, both animals deriving benefit from their association.

Anemone-coloration is a matter of considerable interest. Forms inhabiting warm seas are the most elaborate and striking, but even our own British species are many of them vividly coloured. The full significance of the coloration in these particular animals

is not to be readily understood. The patterns they develop are intimately connected with their structure; and some of their pigments have a physiological significance. In certain cases their scheme of coloration is calculated to render them inconspicuous, so that small creatures swim into their arms unsuspectingly and are caught and eaten; but it is doubtful whether "warning" and "protective" types of coloration have much to do with them, and a good deal of their patterning is at present inexplicable.

Help Wanted.

The British anemones, although less exciting in some ways than exotic species, present many points of interest. A species illustrated in this article, for instance (*Bolocera tuediae*), is a very remarkable



A LARGE BRITISH SEA ANEMONE (*BOLOCERA TUEDIAE*) FROM DEEP WATER.

It may attain a diameter of twelve inches.

[Photo by W. Edgar Evans.]

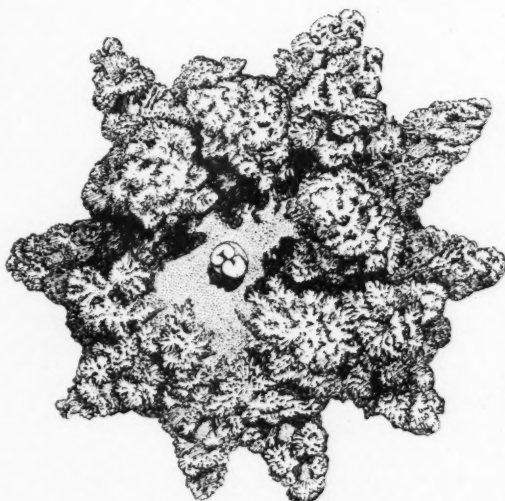
one. It comes from deep water in the Firth of Clyde and other localities, and attains a diameter of about a foot. Every one of its large tentacles is provided, at the base, with a muscular apparatus whereby the tentacle can be snapped off and shed at the will of the animal. The real meaning of this proceeding has not, so far, been satisfactorily interpreted, and the conditions which govern it are peculiar. The photograph here reproduced, for which I am indebted to Mr. W. Edgar Evans, is, as far as I know, the first figure of a healthy living specimen to appear in print.

This article is written partly in the hope that it may catch the eye of a zoologist with experience of marine collecting who would be willing to forward me living specimens during the coming summer. I am now trying to complete the first volume of a monograph on the British anemones, and am anxious to obtain, alive, all described species, so that adequate descriptions and drawings may be prepared. The list of species and directions for packing printed at the foot of this article will give some idea of what is needed, and I should be glad to supply further details by letter to anyone able to help; and would, of course, defray postal expenses on anything sent me.

METHODS OF PACKING ANEMONES.

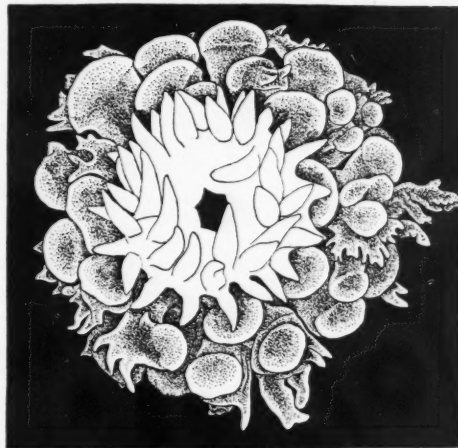
Any of the following methods may be used.

1. The specimens may be put into a glass jar of clean sea-water with a tight-fitting glass top with a cork ring round it; the jar can then be packed in sawdust, newspaper or other suitable packing, in a wooden box. The specimens should not be accompanied by stones or other hard things, which may damage them if swirled about in transit. Not many specimens



ACTINODENDRON PLUMOSUM.

A coral reef anemone which has elaborately branched feathery tentacles and considerable stinging powers. (After Saville-Kent).



PHYLLODISCUS INDICUS.

A species which has plain unbranched tentacles (unshaded in the drawing) and projecting beyond them a ruff composed of complicated outgrowths arising in a circle round the body.

should be put in one jar, and a mixture of anemones with and without acontia should be avoided.

2. The specimens may be packed simply in damp (not wet) sea-weed in a box. The box should be of wood, this being better than a tin, as it lets in air at the cracks and does not promote decomposition. The weed should be of a clean firm species which does not decompose readily—*Chondrus crispus* is a good one (carageen moss). If this is not available, small *Fuci* are not bad; *Ulva* and soft red weeds are to be avoided.

3. Another method is to place the specimens themselves in small glass dishes, or in short wide glass tubes, and then pack the glass vessels in weed in a wooden box. If tubes are used they should not be corked, but may be lightly plugged with weed or with an ill-fitting object, e.g., a cockle-shell; two or three anemones may be put in each tube, if separated by a little weed. If dishes are used, the anemone, as it lies in the dish, may be covered by a bivalve shell of some kind, to keep it in position; the shell can be padded with weed and a string tied round the dish to keep everything in place.

4. Sphagnum moss may be substituted for weed in the above method if it is clean. It should first be dried and then moistened with sea-water. But it must not touch the actual specimens—these, if enclosed in tubes or dishes, and separated from the sphagnum by shells, or even soft damp cotton rag, will be kept moist without contact with the moss.

5. If the anemones are packed otherwise than by method No. 1, method 3 is recommended, as long as a good kind of weed is obtainable. The great object of any method is (1) to allow the anemone to be actually in contact with only damp glass or weed, or a damp shell; (2) to allow it to be surrounded by damp air, and (3) to avoid decay as far as possible.

When weed is used it should not be wet enough to allow the parcel to leak.

DESIDERATA

Gonactinia Prolifera. On sea-weed, hydroids, mussel-shells, etc., typically from more or less deep water, 2 fms. downwards. (Norway, Sweden, North Sea, Mediterranean), Millport and Falmouth.

Ilyanthus Scoticus. Among corbulae and other mud-beasts in 4 fms., Loch Ryan, Scotland. Said to have been found on beach at Balbriggan, Ireland, after a storm.

Eloactis Mazeli. Off shore, 25 fms. downwards on fine sand, etc. (Norway, Mediterranean). Off Rame Head, Plymouth district, 25 fms.; 46 miles W. $\frac{1}{2}$ N. of Tearaght Light.

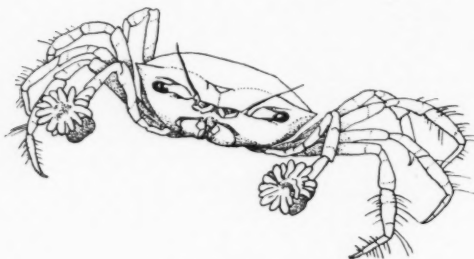
Peachia Hastata. Buried in sand or shell-gravel at extreme low water and downwards. (Denmark, Sweden, North Sea, Heligoland, N.W. France). Torbay; Millport; Port Island Bay; Port Erin; Channel Islands; St. Andrew's; abundant in a limited area in Dublin Bay.

Peachia Undata. Similar habitat to *P. Hastata*. Channel Islands.

Phellia Murocineta. Under stones in pools in caves; overhanging rocks and sides of caverns; close to low-water mark. Torquay; Zennor, Cornwall.

Phellia Picta. On old shells from deep water. Banff.

Phellia Brodricii. Rocks at low water. Lundy Island.



MELIA TESSELLATA.

A crab which carries anemones in its claws. (After Bonadaille).

Phellia Gausapata. Crevices in rocks exposed close to low-water mark at spring tides; also in deep water. Wick, Scotland; Torbay.

Actinauge Richardi. Always in more or less deep water; may be anchored in sand or attached to stones or shells; comes from sandy, muddy or stony bottoms. (Bay of Biscay). Recorded from a number of stations off Ireland, where it is common—e.g., 40-50 miles off Cleggan Head; 3-8 miles off Great Skellig, in 60-80 fms., etc.

Hormathia Digitata. Deep water, usually attached to shells of *Fusus*, etc. (North European Seas). Frequent in region of Gt. Fisher Bank, N. Sea; occurs in N. Sea in 34-55 fms.; recorded off Cornwall and Northumberland.

Hormathia Marionii. Deep water; fixed to various things, e.g., *Dorocidaris* spine. (Bay of Biscay). 53 miles W. $\frac{1}{2}$ S. of Dursey Head in 325 fms.

Hormathia Margaritae. Deep water; e.g. 69 fms.; on shells of *Fusus*, etc. Moray Firth, near Banff; Shetland.

Sagartia Pura. On Laminaria roots; also on old shells from deep water. Coast of Northumberland; western entrance of Berhaven on Bere Island side.

Sagartia Chrysosplenium. Under stones at very low water; in rock-pools. Cornwall—several localities.

Sagartia Ichthystoma. On rocks at low water; also from deep water. Torquay and Weymouth.

Capnea Sanguinea. Deep water. Off Isle of Man, and off Falmouth.

Gregoria Fenestrata. Half-tide level. Near Banff.

Arachnactis Bournei. Plankton. (North European seas; Port Erin, Falmouth, Plymouth, Valencia (Ireland), etc., etc.

Zoanthids and *Edwardsias*. Any species of either of these groups will be valuable. *Zoanthids* may occur free, or on stones and shells, in deep water; or on stones, etc., between tide-marks. *Edwardsias* may occur between tide-marks in old *Saxicava*-holes and such places, or living buried in sand near low-watermark; or may occur in deep water. Species of either of these groups are widespread and may turn up in any good locality.

Sagartid Colour varieties. Interesting colour varieties of the species-group including *S. miniata*, *venusta*, *nivea*, and *rosea* are required; especially intermediate or non-typical forms. This group of species is widely distributed between tide-marks, in pools under stones, in holes on overhanging rocks, etc.

Sagartia Pallida. Further material for anatomical purposes is needed. It occurs between tide-marks, and also from deep water. Dartmouth, Torquay, Banff, Longniddry, etc.

Stomphia Churchiae. Further colour forms of this would be useful in addition to those already seen. It occurs in deep water—not necessarily very deep (e.g., 10 fms.), but may go very deep. Widely distributed in Northern seas.

N.B.—The above notes do not give a complete list of localities, but are meant to give some idea of the places at which these forms may be expected to turn up. Foreign localities are given in parentheses where a species has a wide range.

THE AMOUNT OF OXYGEN REQUIRED IN WALKING.

THE quantity of oxygen inhaled has a profound effect upon the amount of work that can be performed by the body, which requires it to burn the carbon assimilated in the food. The amount required per minute in walking and running rises as the speed increases, and at high speeds, as in a hundred yards spurt, the amount is ten times that required when sitting or standing still. It appears from experiments that the oxygen inhaled during short periods of exercise is used to oxidize lactic acid and carbohydrates in the blood. When the exertions are prolonged it is required for the oxidation of other substances in addition. The body seems to have some sort of "governing mechanism" which controls automatically the quantity of blood passing through the heart according to its oxygen content.

TUTOKAIN.

THIS is the name of another new synthetic cocaine produced by German chemists. A hydrochloride of para-animobenzoyl- α -dimethylamino- β -methyl- γ -butanol, it was discovered among some intermediary products of the preparation of artificial rubber. It is said to possess several advantages over cocaine, is non-poisonous and may be sterilized by heating. Cocaine, of course, cannot be sterilized by heat since it decomposes.

An Instrument which is Set in Motion by Vision.

By Charles Russ, M.B., M.R.C.S., L.R.C.P.

Does the human eye project a measurable force? Here is a new and astonishingly interesting field for investigation. The author has carried out a series of experiments for some years. His results are encouraging and may be confirmed or developed by further independent research. What is this undetermined force which moves the solenoids?

THE human eye has been called "the window of the soul," and it is concerned in the very first instance in our recognitions and introductions and the inter-relations of humanity. At an interview if your eye has not met that of your friend or any other person you are conscious of that omission, and when confronted with a blind person this psychological blank is realized in its extreme form.

Although the eyes may be said to dominate human expression in all its different varieties of manifestation, we do not forget that there are many other features in the countenance which contribute to the revelation of human personality.

I intend only to deal with a few ideas about the human eye. These ideas are, of course, largely founded on facts of universal experience. The first fact I will call the antagonism of human sight. By this I mean the common experience that the sustained gaze of one person soon becomes intolerable if directed into another human eye.

It will be found that two adults cannot continue looking into each others' eyes even by the most friendly arrangement beforehand; in other words, it matters not whether the gaze is friendly or hostile—after a few seconds the attempt will fail. That the force of the human gaze is a real thing is shown by the fact that a person who is perhaps reading or whose attention is engaged by watching the theatre stage or the like, soon becomes aware of another human vision directed towards their eyes. The natural impulse is for the observed to look round towards the observer.

Power of the Eye.

There are also numerous facts of a similar kind which are known relating to the influence of the human eyes upon those of animals. Most of the latter will divert their eyes from a human gaze, though the dog makes his first attention by looking into his master's eyes for a moment, and further, he will be noticed to do the same with his master's friend or foe. He is quite uneasy in the presence of anyone wearing dark spectacles which deny him this view. The influence of the eye must be paramount in the tamer of lions, and it is said that the eyes of serpents

exercise a paralysing influence over birds they are about to devour. This so-called fascination by the serpent's eye is a matter of which personally I have no knowledge, but if true it illustrates this force in a unique manner.

Any bird or animal in the near presence of its devourer usually makes effort to escape by flight. An animal fascinated, however, is held by some power which is strong enough to overcome its own instinct of self-preservation.

What is the Reason?

In the foregoing I have only mentioned facts of common knowledge and experience; they are facts, however, which seem so far not to be explainable. The living eye resembles the photographic camera, since it has a lens in its front part through which all the images of things we see are focused upon a screen or retina at the back of the eyeball. This screen is of remarkable structure and composition, and is, in fact, the end of the optic nerve through the fibres of which all impressions of sight reach the visual area of the brain.

Coming back to the antagonism of vision, there is no reason to suppose a resisting force to be operating if two cameras merely were facing each other a few feet apart. Nor again, is there any discomfort or antagonism between human beings who may be seated side by side in a row of pews or stalls. I suspect, however, that the prevalent habit of reading newspapers in railway trains, or other situations in which people are seated in opposite rows, is intimately connected with the subconscious desire to avoid the row of eyes opposite.

We can legitimately consider all the sight impressions and images which we perceive as visual *imports* which are all constantly coming into our eyes and being utilized.

If now we indulge in a flight of fancy and imagine that there is also an exported ray or invisible beam coming out of the eyes and to which any retina is sensitive, we have at once an explanation of the antagonism of vision experienced in the facts which I have referred to.

The eye being sensitive to anyone else's eye-ray, feels its intolerance and looks away when stared out of countenance. The lion has to avoid the gaze of its tamer, and in the children's game of "Stare each other out" one pair of the opposing eyes will certainly have to give way.

Test Apparatus.

To give support to the idea of the invisible ray which I have supposed, it was necessary to try to find some experimental evidence. For instance, if an instrument could be devised which would go into motion by no more than a human glance directed at it, there would be substantial evidence in support of my theory.

My first experiments were based upon a guess that the supposed ray might set up a small electrical change in a coil of wire, or perhaps in a suitable electrical condenser, or again that it might be able to disturb part of the earth's magnetic field.

Electrical science knows that if a varying magnetic field meets a coil of wire an electric current may be generated within the coil. Such a current-carrying coil becomes a magnet, and if suspended and free to move it will turn into the earth's magnetic meridian, *i.e.*, the north and south line of the room.

This movement is the visible evidence of the invisible variable magnetic field.

The first experiments consisted of suspending a coil of fine wire within a metal vessel furnished with a window—the metal box being connected to earth.

The coil was hung on a fibre of unspun silk by means of a chimney about a foot long mounted in the lid of the box. The silk fibre was attached to a cork in the top of the chimney and its lower end carried a small metal stirrup to which was fixed a small magnet about half an inch long. The coil of wire was joined up at each end, forming a handle or loop for suspension from the stirrup. A scale below the coil showed the zero position and any movements of the coil could

be measured. Such a coil does show a movement in the horizontal plane when the eyes are directed at it within a distance of easy vision. This is best seen if one looks through the centre of the coil in a diagonal direction from one end to the other. After it has moved to the maximum possible and the sight is withdrawn, it will return to its initial position by the power of the little magnet in the stirrup. This magnet is only a control.

The movement which can be induced is small, but is capable of magnification by means of the spot of light method directed on a small mirror which can be fixed on the stirrup and reflected on a scale.

The axis of the solenoid should be mounted at right angles to the axis of the small magnet in the stirrup. In this way the rest position of the solenoid will not be already in the same line as the earth's north-to-south field.

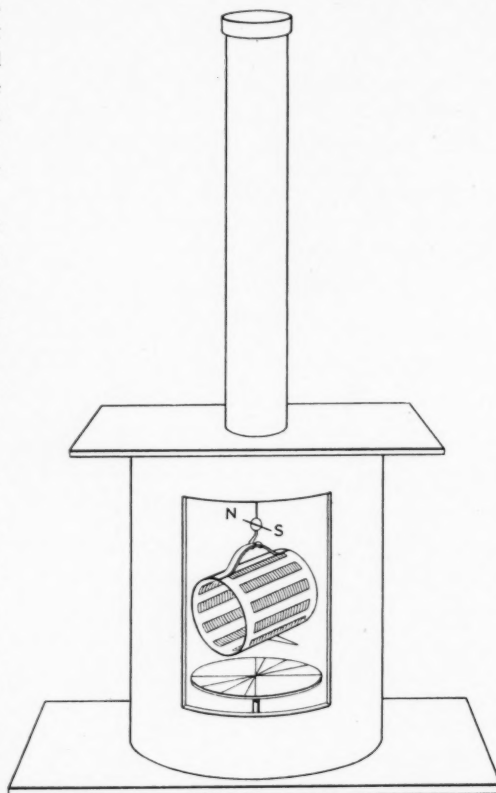
I soon encountered what can be called the "fresh effect." Soon after such a coil is put into the case it goes through a certain amount of rotary motion (wandering) due to the handling and air currents. This must subside, of course, before any observation of sight is attempted, yet immediately after coming to rest it is repelled most actively by vision. Within about a minute this effect passes off and the movements subsequently obtainable are smaller but consistent. It

must be clearly stated that the "fresh effect" is not the same thing as "wandering."

Coils Used.

A very large number and variety of coils were used and the larger ones needed to be wound on some kind of frame, either paper, celluloid or mica, and this type was noticed to be more active than the plain coiled wire.

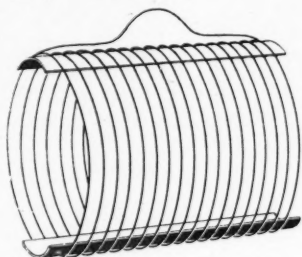
The idea arose that there might be a kind of condenser effect. I therefore tested a large number of cylinders made of mica containing no coil of wire,



THE CONDENSER
in a metal casing which is connected to earth.

but which had strips of lead or aluminium foil mounted on the inner and outer surfaces.

If such a condenser is suspended in a draught-proof metal case it is also caused to rotate under a steady gaze, particularly if it is made of a large size, *e.g.*, 4 in. long by 3 in. diameter.



A COMPOUND SOLENOID.
Each ring is a separate closed circle of wire.

The movement is obtained within five seconds, and may amount to thirty degrees of the compass or more in conditions of dry weather, and it will be about half that amount and more slowly induced in wet weather with a low barometer. But I found that these condensers also move slowly from their zero (overcoming the control magnet) under influence of electric light or sunlight or bright light.

If such a condenser is suspended between two insulated metal plates within a glass case, and the plates are charged to one hundred or two hundred or several thousand volts, it rotates under the stress, so that its long axis lies in the line of stress, and it remains steady under this force in the absence of vision.

Vision, however, causes a rotation under these conditions also. Movement is obtainable if the solenoid or condenser is completely submerged in a glass vessel containing paraffin oil.

It is apparently diminished but not abolished in a low vacuum, but a test in a very high vacuum has not yet been made.

Ideas as to the cause of the movement.

Draughts.—These are excluded by the complete enclosure of the apparatus.

Heat.—To test whether these effects might be due to radiant heat a number of experiments were undertaken.

Aluminium saucepans with hot and with boiling water were fixed on either side of the container and the results of the observed movement were compiled in tabular form. They showed that the movement induced by this heat was either nil or amounted to a quarter of the degree obtainable by vision.

The details of these heating experiments are shown in my article on this subject in the *Lancet*, 30th July, 1921.

The fact that movement of the model occurs when submerged in paraffin makes heat a very unlikely cause of the effect.

In some of my later models also—weighing over twenty grams—rotation occurs by vision through an opera glass twelve feet away.

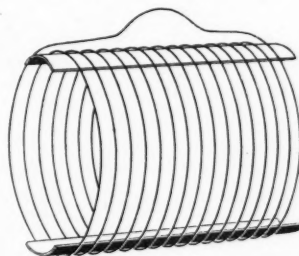
An electromagnetic or electrostatic stress.—Apart from the human body the condensers and the solenoids are set in motion by the approach of a charged glass rod or by the field from an electric lamp. Although moved by the latter a certain position is taken up which is maintained under the steady field of the district supply of 240 volts direct current.

Some Problems.

So far the experiments seem to show the power of the human body at short range and human sight at long range to disturb an electrostatic system whether natural or electrically stressed.

One of these cylindrical condensers is not a coil or apparently capable of offering a path for a current, and it is difficult to account for the movement.

Moreover, if one of these condensers is suspended within a glass vessel lined by finely perforated zinc sheeting, which is earthed, it will turn so that its axis points towards the observer three feet away, and it will move appropriately with his change of position. It will do the same thing if he sits with the back of his head towards the instrument.



A SIMPLE SOLENOID.
Each ring is a spiral and the two ends are connected by the loop.

It is known that an electrostatic charge does not traverse a fine metallic grid such as commercial perforated zinc (two millimetres aperture), yet something due to the human body is causing the condenser to turn within such a metallic cage, although the approach of a highly-charged glass rod leaves it unmoved within such a cage. This suggests that the force under consideration, if [electrostatic, is also magnetic or electromagnetic.

Some further experiments were undertaken by attempting to interfere with the working of a wireless broadcasting set in case evidence of an electromagnetic disturbance could be found. The results were inconclusive, but it was not forgotten that the electromagnetic wave—possibly responsible for these results—may be too remote in wavelength and probably in strength from any which operate in wireless broadcasting.

Results Summarized.

When making experiments and observations with these coils and solenoids it is hardly possible to avoid a condenser arrangement as they all have more or less capacity.

Perhaps the most satisfactory experiments so far are those showing the rotation of a condenser which is really a coil of a special type surrounded by a sheath of another metallic nature with an electrical insulator in between.

The human body is the seat of various electrical changes during life. All the muscles show electrical currents and variations of potential during action.

There is an electrical change with each heart-beat, and the retina of the eye also shows minute electrical activity during vision. All these currents have, of course, appropriate electric fields. But these must be extremely small and in practical work they do not disturb the most sensitive electrical or magnetic instruments in ordinary use.

If the results are summarized I find human vision is able to disturb electrostatic and other electric systems. This is shown by:—

- (1) The motion induced by human sight being directed at a suitably-arranged condenser.
- (2) Similar effects follow the direction of sight at a suitable kind of solenoid.
- (3) The same result follows if the solenoid is set within the field of a bar magnet.

Physiology teaches that the human body is not magnetic, and this of course means that it does not attract an ordinary steel magnet or compass.

We remember that the electrical changes which accompany activities of our muscles and nerves are producing various electrical fields, and these persist throughout life and they vary with the degree of our activity, both mental and physical.

Nevertheless, they are quite small and no account is taken of them in health in routine medical work nor in everyday life. Perhaps one exception should be mentioned of electrical variations in heart and nerve disease.

After a study by these experiments since 1917 I am satisfied that an electrical force is constantly leaving

the body during life. It is apparently generated in the brain and escapes chiefly through the eyes during sight.

Children are as well able to move these indicators as adults, but the degree to which anyone can deflect the indicator varies considerably. When the same indicator was used on which the average person deflected the needle fifteen degrees, I have seen it move quickly to sixty degrees under the gaze of one of our brilliant actresses, and a similar result happened when a flying officer (an ace of aces) focused his sight upon it.

Conversely, if the health is poor there is little effect produced. A middle-aged man could scarcely move the indicator and asked me if I thought it was due to a cataract which his oculist had warned him was forming. A man under thirty in the early stages of palsy of the spinal nerves also failed to make more than a trivial impression on the instrument.

I quite expect the field of utility will be much enlarged with further and wider study in many other hands than mine.

FACTS ON INDIAN POISONS.

THE Report of the Chemical Examiner's Department of the Government of Madras for the year 1923 shows an interesting variety in the poisons used in ninety-two cases of human poisonings. The most common was mercury, found in twenty-seven cases, the next arsenic, in twenty. Opium was found in twelve, aconite in eleven, steander in six, strychnine in five and atropine in four. The cruder poisons which are more usually associated with the Oriental, at least in works of fiction, are not so popular as writers would have us believe, there being only one case each of powdered glass, nitric acid, lysol and kerosene oil. Datura, an alkaloidal poison similar in its effects to atropine and belladonna, was found in four cases, and was used as an aid to robbery. In one case the datura was given in coffee, and the victim feeling giddy twenty minutes later reported to the police, who arrested the poisoners and found on them these packets of yellow seeds which yielded a large quantity of the poison on chemical examination. The victim recovered after five days in hospital.

THE gun-boring works of the Twidvale Steel Co., U.S.A., have recently been engaged in making steel boilers, four inches thick and four feet in diameter. These gun-steel boilers will be of the Babcock & Wilcox type, but for super-pressure steam at 1,200 lb. per square inch and a temperature of 700° F. They will supply the turbines at the new Edison generating station at Berton.

The Discoveries at Gîzeh.

By T. E. Peet.

(Professor of Egyptology in the University of Liverpool).

Has the tomb of King Sneferu been discovered? It seems possible, although the newspaper accounts have given conflicting reports. In any case the new find, whatever it may turn out to be, is associated with his dynasty and may throw light on an almost unknown period of history.

EVENTS in Egypt move rapidly and continue to give the lie to those who were inclined to think that the country's antiquities were all but exhausted. For many years the Boston-Harvard Expedition, under the leadership of Dr. Reisner, has patiently worked a concession round the great pyramid of Khufu or Cheops at Gîzeh, a few miles south-west of Cairo. From the scientific point of view its efforts have been more than rewarded, though they have never been spectacular enough to appeal to the general public. Now, however, it would seem that it has found something big enough to arouse general interest even in a world sated with Tut-ankh-amen. The new tomb is evidently an underground chamber reached by a vertical shaft no less than 150 feet in depth. We are not told its position, but from Dr. Reisner's statement in Boston that its superstructure had been destroyed by the causeway leading up to Khufu's pyramid-temple we may infer that the tomb lies to the east of the pyramid. The only facts as yet known to us regarding its contents are that there is a plain sarcophagus of alabaster and a number of wooden poles, the tops of which are gilded; beside the coffin is "something resembling a plank" with inlaid inscriptions, among which is visible the cartouche of King Sneferu, the last known king of the third dynasty, who ruled about 2,900 B.C. The objects lying on the floor of the tomb comprise vessels of alabaster and copper, and pieces of gilded furniture, the wood of which, however, is badly decayed.

The Cartouche.

Such are the facts, and conjecture is already busy with them. She seems to be concerning herself mainly with the question whether this tomb contains the body of King Sneferu himself. This possibility has naturally been suggested by the occurrence of his cartouche on the "plank," a fact which, however, can prove nothing until sufficient of the inscription has been observed to show in what context the king's name occurs. It has moreover been rightly pointed out that Sneferu possessed a pyramid at Mêdûm, some fifty miles to the south. Dr. Reisner, too, has stated his belief that Sneferu was buried under the so-called

false pyramid at Dahshûr, sixteen miles south of Gîzeh, where has been found the tomb of a priest attached to his pyramid-cult. If this opinion be correct, to assume that the new tomb is that of Sneferu would be to suppose that he built no fewer than three tombs for himself. This is *a priori* not impossible: other Egyptian monarchs had more than one tomb, and we have a good parallel from this same third dynasty when Neterkhet-Zoser built for himself a vast brick mastaba-tomb at Bêt Khallâf and the step pyramid, the earliest of the pyramids, at Saqqâreh.

Possible Value.

These duplications of tombs are usually explained as a measure for obtaining greater security for the king's body: the more imposing structure might attract the attention of the tomb-robbers while the royal body lay unsuspected under a more humble monument, and if one "dummy" told for security then two should be even more efficacious. For these reasons we must not rule out the possibility that Sneferu's body lies in the new tomb, though it is on the whole more likely that the owner will prove to be a member of the royal family or, failing this, a noble of the highest rank. That he was a person of great importance is indicated by the depth of the shaft and the richness of the funerary furniture.

What is the archaeological importance of the find? It lies in the fact that up to the present we have not a single example of an untouched rich burial of so early a period, say 2900 B.C. or thereabouts. It is unlikely that the tomb will produce material of much historical value in the form of inscriptions, for the inscriptions found in tombs are usually very short and of purely funerary content. The tomb of Tut-ankh-amen should warn us against expecting anything in the way of history, but even if the inscribed objects merely teach us a little more about the relationships of the royal family we may consider ourselves fortunate. The value of the objects is far more likely to lie in the insight which they will doubtless give us into the products of a period when Egyptian art, and probably science too, reached a level rarely equalled in later times and never surpassed. Con-

siderable interest, too, will centre round the contents of the coffin itself, for our knowledge of the means taken to preserve the bodies of royal and noble persons at that remote epoch, before mummification in the full sense of the term had come into general use, is lamentably small.

It is a curious fact that discoveries in Egypt rarely come singly. Here we have a tomb which dates in, or possibly shortly after, the reign of Sneferu, the last known king of the third dynasty, and perhaps the immediate predecessor of Khufu who built the great pyramid. Only fourteen miles to the south, at Saqqâreh, the Service des Antiquités has been working for the last two seasons on the step pyramid, known to have been built by another king of the same dynasty, Neterkhet-Zoser. Not only has the interior of the burial chamber been cleared, but in a funerary chapel attached to the east side of the pyramid has been found a painted limestone statue of Zoser himself. With the exception of two figures of King Khasekhemui

of the second dynasty this is the oldest royal statue yet discovered in Egypt. Of Zoser we know virtually nothing except that a famous wise man, the "father of Egyptian medicine," Imhotep, is said to have lived in his reign. Nor is our knowledge of Sneferu much greater. Among the turquoise mines of the Wâdi Maghâreh in Sinai he has left a rock-tablet recording an expedition thither. On the Palermo Stone, a fragment of a year-by-year chronicle of Egyptian history drawn up during the fifth dynasty, there are a few partially mutilated entries concerning him. We learn that he built several large buildings and ships, and imported in one year forty ship-loads of cedar wood, doubtless from Syria; also that he made a successful campaign against the people of Nubia and brought off 7,000 prisoners and 200,000 head of cattle. To such laconic statements as these is our knowledge of the third dynasty limited. Hence the importance of any find which may possibly throw new light on so dark a period of history.

NON-FERROUS METALS RESEARCH.

THE future of engineering and electrical progress depends in no small measure on advances in our knowledge of metals, and the subject is therefore of considerable importance to the community.

In this connexion the work of the British Non-Ferrous Metals Research Association, of 71, Temple Row, Birmingham, is of interest as it provides an organization by means of which the financial support of individual firms is pooled to foster research, the funds thus rendered available being augmented by a contribution from the Government Research Department.

The present position of this association has just been reviewed and its research work, on which £16,000 per annum is now being expended, is described in a report just issued.

Some twenty-five investigations have been put in hand at the National Physical Laboratory, Research Department, Woolwich, the universities and in the works.

Brief and clear descriptions are given of the aims, progress and practical applications of the individual researches, which cover a wide field. Several deal with copper and brass, others with aluminium, zinc, lead and nickel; whilst metallurgical problems of great importance to engineering are being attacked, including the prevention of the wastage of locomotive

fire-box stays, the search for alloys suitable for high-temperature service, and die-casting alloys. Other investigations are in hand on the soldering of metals and on atmospheric tarnishing and corrosion, which affect even wider interests including the building industry and even the eventual public and private user of metal construction and appliances.

Further sections of this interesting pamphlet show how successful the association has been in securing the co-operation of leaders in the industry with the foremost scientific metallurgists, and give some indication of the rapidly accumulating results of the work.

Now that it is firmly established the association is anxious gradually to become self-supporting, by an accession of new members from the non-ferrous industry itself and from the engineering and other users who stand to benefit by the results of its labours.

It is clear that much of the work described can only be undertaken by the co-operative effort of the industry, and it is hoped that more will share in the obligations and privileges of carrying it out in steadily increasing measure.

Such research already embraces some fundamental scientific work, but is mostly concerned with the direct application of science to practical problems, and one can readily believe that it is on such foundations that new industries arise and old ones become rejuvenated.

Concrete—from Rome to Wembley.

By C. Harrison Townsend, F.R.I.B.A.

Concrete is the most important of all building materials, and if properly made it is even more durable than stone. In the hands of artists and architects beautiful work is being done with it, and centuries hence some twentieth-century concrete work may be among the great historical art treasures of the world.

WITHIN the past few years, and with an increasing insistence, the consideration of concrete in building construction has claimed more and more of the thought and effort of the architect and the engineer, and—as we all know—has slowly but surely extended its appeal till it has at length become a matter of interest to—very literally—the “man in the street.” To him its use is growingly apparent in the highways he passes through, lined with huge buildings largely possible owing to the economy of its adoption as their main material. His roads carry him across chasms by its bridges, or lift him to a higher level by its viaducts or gradients. Concrete now even makes its claim to have something to say in the problem of that housing question which, it would appear, is ever with us, and to offer, under conditions, a material for building even the smallest house, with, so it is claimed, advantages in cost and simplicity of method.

Cement and Concrete.

There is a frequent confusion in everyday speech between cement and concrete, and the terms are often vaguely used as though interchangeable. This need not be the case when it is made clear that cement not only can exist on its own account, but that it also is an ingredient—and the main and important one—in the composition of concrete. Its uses on its own merits are to add immensely to the solidity and strength of a wall, when it takes the place of lime in the mixture of the latter material and sand which we call mortar. Again, it serves as a covering to the face of a wall which, when thus treated with a layer about an inch thick, becomes weather and wet-proof, and in the same way it is employed as a floor surface laid to a level face upon a concrete or other base.

As we all know, there are a hundred and one adhesive mixtures used in the workshop or the house, and known

as cements. It is, however, not to such adhesives as these that this article refers, but to the entirely different material made use of by the builder and engineer. Using the word cement in their sense, it is applied, in the first place, to certain limes which, when set, are not acted upon by water, and are the result of “burning” pure chalk or limestone till their carbonic acid has been driven off. This hydraulic cement has the advantage of being slow setting, while “Roman” cement, another variety of natural cements, is used where a quick-setting material is required.

It is, however, mainly with what is known as Portland cement that this article is concerned. Not, indeed, that this material derives its name from the fact that it has any direct connexion with the place Portland. It owes its name, as a matter of fact, to Joseph Aspdin, of Leeds, who, towards the end of the eighteenth century, experimented in the manufacture of a material to meet the growing de-

mand for cements that were hydraulic—that is, that would, when set, resist the action of water, a property not possessed in full measure by lime. He found that a mixture of clay to the extent of 25 per cent with 75 per cent of finely-ground limestone, when calcined and ground gave a material entirely satisfactory as regards its tenacity and its hydraulic properties. From its colour and appearance, somewhat resembling Portland stone, he applied the name Portland to it.

Modern Methods.

In our own time the burning process necessary for the calcination of the calcareous and argillaceous components—the lime and silica mentioned above—is no longer effected by the old-fashioned chamber or bottle kilns, but by rotatory cylinders of steel some 100 feet long by 6 or 7 feet in diameter, and lined with refractory brickwork. These are slightly inclined and

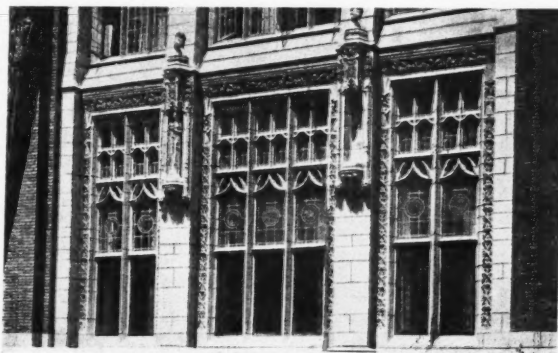


FIG. 1.
GOTHIC WINDOW IN CONCRETE.
Detail, Tower Court, Wellesley College, Boston, Mass.

the raw materials, fed in at the upper end, thanks to their rotation descend to the lower end, where they are subjected to intense furnace-heat. A direct blast method for fusing the two materials together is also largely used. The resultant powder should be so finely ground as to stand the test of a sieve with a mesh of no fewer than 76×76 meshes to the square inch. So much for cement and the short reference to its manufacture and qualities necessary before entering upon any consideration of its use in that important material in our world of to-day—concrete.

The definition of the word concrete is a simple one. It is virtually a synthetic stone—composed of broken stone or similar material, sand and some kind of cement. Water added to these, and the component materials thoroughly and uniformly distributed, they combine in a solid mass, and form, as has been said, a rough, strong and homogeneous artificial stone. Its advantages are the simplicity of its manufacture, the prevalence throughout the world of the materials necessary for its composition and the fact that when semi-fluid it can by means of moulds be made to take any desired form.

The cement or *matrix*, used by Roman builders in their concrete, of which so many fine examples remain, was a lime, but the use of this has been largely superseded by Portland cement on account of the much greater strength of the latter. The broken stone or broken bricks or slag—the aggregate or ballast, as it is called—vary in their proportion to the amount of cement from 3 to 1 down to 7 or 8 to 1.

Importance of Mixing.

The thorough mixing of the constituents, so as to distribute them evenly throughout the mass, is a highly important part of the process. In smaller work this can, with advantage, be done by hand, but where a large mass has to be mixed the use of a mixing-machine is usual. This consists, in a general way, of a large iron drum in which the materials are placed, and which by its rotation, hand or power-produced, thoroughly mixes together the matrix and aggregate. This is the process which our local authorities give us only too many opportunities of seeing in the repair of our roadways.

As for the use of concrete, this extends far back into the past. The Romans, far inferior to the Greeks in artistic originality, were their superiors in engineering invention and boldness. The stone lintel construction of Greece narrowed the power of design to a limit of possibility from which the Roman builder escaped by discovering that he could cover, for instance, the enormous vaults of the great *thermos*, the Basilica of Constantine and the like by one solid lid-like piece cast in semi-fluid concrete. For their walls, the Romans

made frequent use of concrete cast in a mould, formed of planks retained on either side of the future wall by upright props—exactly as was done in building the Stadium at the British Empire Exhibition.

From the mammoth undertakings of the engineer to the smallest use by the farmer in the shape of his gate and fence-posts, concrete to-day plays its indispensable part. The reinforced aqueduct supplying New York with water is 111 miles long and in places has a diameter of 17 feet. A portion of it runs 1,100 feet below the surface of the ground, and its wonderful delivery is 500,000,000 gallons a day. In its other method of use, that is when the material is cast into blocks, treated after the manner of masonry-building, the American engineers employed it, on a large scale, for the buildings in connexion with the Panama canal. It was, however, principally in the form where strength

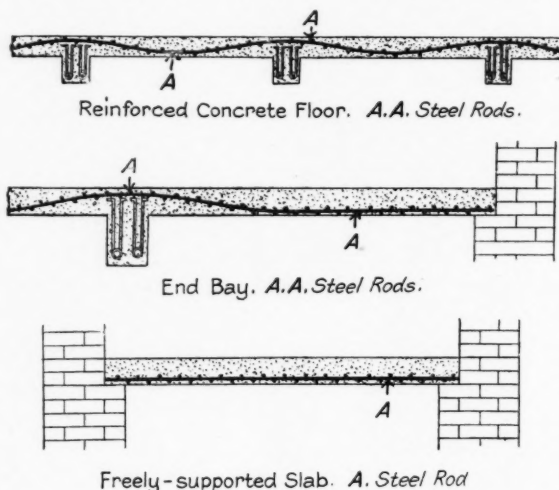


FIG. 2.

was gained by mass, and for the bridges, retaining walls and viaducts, so especially familiar to us on our railways, that its usefulness was at first recognized.

The Romans, in the first instance, however, in their engineering works, and the later users of concrete generally up to our own time, were under a disadvantage that to-day does not exist. To obtain strength in their walls they had to rely on mass and bulk. To such an extent was this the case, indeed, that the concrete walls of the Pantheon have a thickness of no less than 20 feet. So huge a use of material is unnecessary to-day, thanks to the introduction, only some fifty or sixty years ago, of the principle of strengthening a concrete floor or wall by building-in a network of steel rods. As with so many inventions, this new departure, now of world-wide importance, came about from the almost accidental use by Joseph Monier,

a French gardener, of iron rods which he built into the walls of a concrete water basin he was forming. To him is due all credit for pushing vigorously this invaluable invention. The principle—and especially in France—was seized on by various manufacturers, each of whom claims special advantages for his own system of reinforcing. All of the processes, however, are based upon Monier's discovery in 1868 that the introduction of small rods where the tensile stresses occur in a layer of concrete, increases the strength of this so enormously that its thickness can be most materially reduced.

For walls, columns, beams and slabs, reinforced concrete is now used in growing degree, and is extending its domain to cover ground undreamt of a few years ago. While building the Nile barrage its use, for instance, in the formation of piles, was discovered by our English engineers when faced with the impossibility of obtaining timber for this purpose in the treeless country around Assuan. Here Sir Benjamin Baker made use of steel rods embedded in a cast mass of concrete.

Reinforcing.

In place of—or better still, as well as—rods for the purpose of strengthening, it was later found that, as an efficient reinforcement, a sheet of iron or steel formed into a net-like series of meshes could with advantage be substituted for the rod system, with equal gain in strength and a manifestly improved ease in working. For floors either this method is largely employed, or some modification of the Monier system, consisting of a horizontal network of steel rods buried in the concrete (Fig. 2). In other systems thin wires are used instead of rods, and are allowed to take a sagged line in the thickness of a floor (Fig. 2) instead of being stretched tight from wall to wall or beam to beam.

It is in the latter—the beam—and its design that the engineer has shown most invention. His object has always been to place the bars where the tensile stresses occur, and where these are especially heavy the portion of the beam under compression is reinforced with an upper series of somewhat smaller bars.

Not only in peace and its conditions is the utility of concrete for structural work being recognized. In the new demands made by the art of fortification during the Great War it played its part—and especially with the Germans—in the formation of the *Feste*, or small self-contained fortress, demanded by the modern "group" principle of siegecraft, and in the "cupola"—that largely-adopted means of protecting gun-mounting by armour and concrete. This latter material, reserved before 1914 for permanent military work,

during the War came into prominent use for heavy field works as well, as, for example, was shown by the magnificently successful *Feste* at Verdun, where a protecting outer casing of 10 feet of reinforced concrete proved a sufficient thickness to withstand the volcanic bombardment of the monster mine-shells of even 42 c.m. calibre. The efficient construction of the "pill-box"—the German *Maschinengewehr-Eisenbeton Unterstand* (for which their soldiers made the merciful contraction of "Mebu")—and, also, from the end



FIG. 3.—"THE SPIRIT OF THE ROCKS."
Life-size concrete figure by Mr. F. Doyle-Jones. This shows the capabilities of concrete as a material for the sculptor.

[Copyright, Fredk. Coleman.]

of 1916, the trench communications, where possible, consisted of a sheathing of corrugated iron covered with from 3 to 5 feet of concrete.

Apart, again, from its use in war (which it is to be hoped may have a poor future in front of it), there have been not altogether unsuccessful attempts on the part of ship-builders to employ reinforced concrete. Not only, as at first, did they do so (and especially in Holland) in the construction of canal-barges, but ships have been satisfactorily built of it, up to no less a tonnage than 7,500 tons. The method, promising enough, awaits however further development.

A somewhat unexpected property inherent in the material has been noticed by the architects of the British Imperial Exhibition at Wembley. The whole of the many flagstuffs, by a happy inspiration of theirs, are cast in concrete and they have been found all the more serviceable because they are not absolutely rigid, but possess a swaying or bending property that allows them to "give" slightly under the influence of wind. This faculty opens up a wide field of consideration for the concrete engineer. He may find that it was one of the factors responsible for the remarkable success of concrete buildings, when compared with those of all other materials, in holding their own and resisting the shaking-down effects of the late great earthquake in Japan. That the few buildings left standing in the miles of devastation should be those built of concrete—such as the Russo-Asiatic Bank, the Yusen Building and others—is a matter of so much consequence to a nation that has to rebuild entire new cities that the Carnegie Institute of Washington has sent an expert, Dr. Bailey-Willis, to investigate and report in detail as to the lesson engineers have to take to heart. They await this with keen interest.

Surface Effects.

It would be an injustice to deal with the subject of concrete buildings without paying a tribute of recognition to those responsible for the highly important example of its capabilities demonstrated at the Exhibition at Wembley. True, the opportunity was unique; the problem included, on a huge scale, the assertion in the highest degree of the three main attributes claimed by concrete as a building material—economy of cost, exceptional speed resulting from its use, and, in this case, a more than usual compliance with æsthetic claims as regards the design of the interior and exterior of the various buildings.

The architects, Sir John Simpson and Mr. Maxwell Ayrton, in association with Sir Owen Williams as engineer, not only approached their constructional problems with boldness but did so as artists of originality, and of a discretion that does not, in these days, always go with that attribute. As an example of their inventiveness their treatment of the wall surface of their buildings was a veritable inspiration. Concrete when poured between boards or "shuttering" placed on either side of it, with a view to its forming a wall, being a plastic material retains, when the shuttering is removed, the impression of the joints of the horizontal planks forming the mould, which leave, on withdrawal, a distinctly untidy and unsatisfactory finish of the wall-face. By nailing small fillets where the joints occur, and treating the surface

of the shuttering-planks with a series of vertical small grooves, an effect was obtained somewhat similar to that of "rusticated joints" with "tooled" face between them. This, of itself, meant that concrete can now be used so as to express itself frankly, and need no longer have its unfinished-looking face roughcasted over, or floated with cement.

The flag-masts have already been mentioned. The fence-posts, large and small, are also of reinforced concrete, and an ingenious use of it has been for the countless lamp-standards that line the roads and paths (Fig. 4), and by their pleasant design add so much to

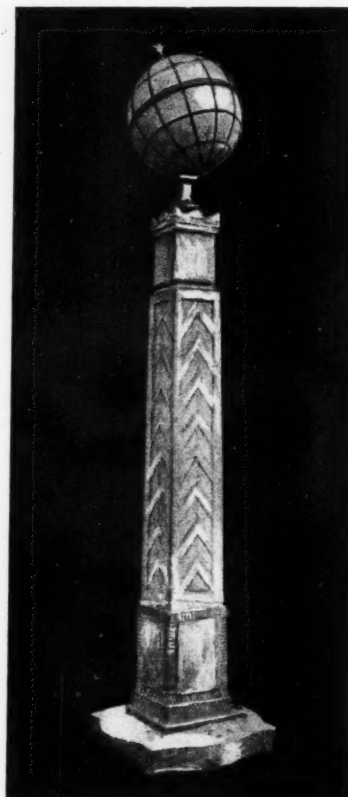


Fig. 4.—CONCRETE LAMP-POST,
British Empire Exhibition.

the gaiety of the layout of the grounds. Indeed, not only in such semi-architectural uses as this last is it beginning to be recognized that concrete may make good its claim to a position alongside stone and marble for the sculptor's work. The illustration (Fig. 3) of "The Spirit of the Rocks" (a life-size figure modelled in white concrete by Mr. F. Doyle-Jones, and lately exhibited in London) shows the capabilities of the material as being one that is alike pleasant for the sculptor to employ, and responsive to his aims.

Thin Films and Their Uses.

By H. E. Parry, A.C.G.I.

Thin films are among the most interesting of our scientific curiosities and may find an increasing practical application in ultra-delicate mechanisms.

THE title of this article is drawn from a field of scientific research connected with the phenomena of surface tensions, and although it may appear to be a dry enough subject when followed through the medium of the textbooks, it is by no means so when the essential facts are extracted. Besides this, more than one valuable invention is derived from this field of work.

It will be obvious to anyone, after a moment's thought, that the conditions at the surface of a body, particularly a liquid substance, differ considerably from those within the mass of the body. Let us take the case of a speck of dust floating on the surface of a glass of water. If it approaches the edge of the liquid surface it suddenly is drawn as by an invisible force to the sides of the glass. That same speck of dust, when it begins to sink through the mass of the liquid, is no longer attracted to the sides.

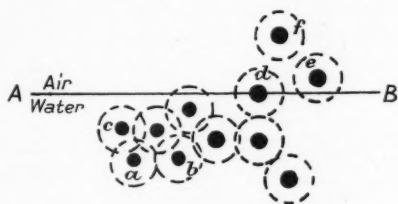


FIG. 1.

Molecules *a* and *b* are just within reach of each other's attraction; *a* and *c* pull each other strongly; *e* is just within the united pull of the liquid mass, but is pulled on one side only; *f* is beyond the attractive force of the liquid, and escapes as vapour.

It could be shown by similar experiments that the surface of a solid also has within it forces at work which are not compatible with the conditions in existence within the mass. In Fig. 1 the surface of a liquid is imagined as it would be magnified to a degree that is beyond the capability of any microscope. Nevertheless, this diagram is not pure supposition.

Cohesive Forces.

We have every reason for supposing that there are particles, or more accurately, systems of particles, which may be called molecules. These molecules may be represented by the black dots. Now in a liquid the molecules attract one another and the range of this attraction may be represented by the dotted circles. Two dotted circles just touching may therefore be taken to denote two molecules only

within range of action of each other. The mass of a liquid should therefore be shown as a system of interlacing dotted circles. This must be so because a liquid has cohesion. It is this cohesive force which is being broken down in the work done to boil water. In other words, the latent heat of steam is a measure of the cohesive force of the water molecule. These molecules are, of course, in constant motion and the diagram shows what would be an instantaneous picture of the structure; and, moreover, the line *A-B* is a purely imaginary line denoting the surface. A liquid in a sense has no absolute surface, for like a saucepan full of pop-corn it has a top layer of molecules which are in a state of ferment, being continually shot out of the mass and falling back into the mass by the pull of the other molecules.

Surface Tension.

In Fig. 1 molecules such as *a* and *b* whose limits of mutual attraction are just touching, could be easily driven apart by an increase of heat, for the effect of heat is to increase the mutual bombardment of the molecules against each other. Those such as *a* and *c* would be more difficult to divide. If a pair were loosely bound and also near to the surface as in the case of *d* and the one below it, then *d* would tend to fly out of the liquid as in *e* and *f*. It should be noticed, however, that *e* is still within the pull of the liquid mass, whereas *f* is outside it. Again, it should be particularly noticed that the molecules on the surface of the liquid are pulled only on one side, there being none above them to equalise the action as in the case of those within the body of the liquid. This would tend to set up a tension in the surface. To make this point more clear, imagine that the surface *A* and *B* were curved. Seeing that all the molecules in that surface are being pulled inwards, the surface tends to crowd the particles together so as to take up the minimum amount of room. In other words, the surface tends to make itself as small as possible. There is also one other point of interest and importance when considering the action of films: whether these be solid or liquid, the surface of the substance is continually giving off molecules of its own substance at a rate that depends upon the degree of saturation of the atmosphere immediately above it.

In the case of a soap-bubble, or other thin film, there are two surfaces within appreciable distance of one another. The thinnest soap film is about one hundred molecules in thickness. In Fig. 2, *a* and *b* are two molecules in the surface of the film of, say, a soap-bubble. It is clear that the mass of the liquid exerts a considerable pull upon the particle of the surface and that the tendency would be for quite a considerable force to be required to rupture the film through the plane of its centre, because all the molecules are bound together by their cohesive force and, moreover, a large proportion of these are pulled on one side only, namely towards the centre of the film. We would expect to find that the tensile

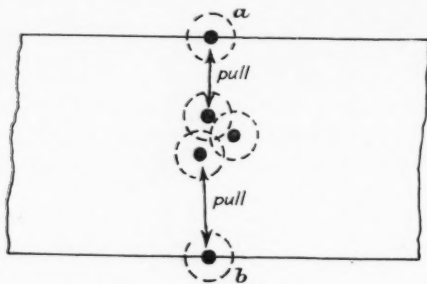


FIG. 2.
In a thin film molecules *a* and *b* are attracted on one side only, setting up a tension in the surfaces.

strength of the film was in proportion to its cross-section, much more than that of a mass of the same substance. This partly explains why a thin film of adhesive is so much stronger than a joint made with an abundance of cement or glue. Not only does a careless workman waste the cement, but he also gets a weaker joint. The increased tensile strength of the film is also effective to a certain degree across the section of the film, as will be evident from the diagram, for the forces are exerted also diagonally on the molecules of the surfaces.

Practical Experiment.

With a little celluloid and amyl acetate, some interesting experiments, which later will be shown to have a practical value, may be performed. Both substances are highly inflammable and should not be brought within many feet of a flame. In about two ounces of the acetate dissolve thirty grains of celluloid. Photographic films, cleared of their gelatine by immersion in hot washing soda and water, will suit. The amyl acetate may be bought from any local chemist, but it is very much cheaper to buy it by the pound from a wholesale chemist. The price varies from about 5s. 6d. to 6s. 6d. a pound. The

celluloid should be cut with a pair of scissors into fine chips to facilitate solution. The solution is best conducted in a stoppered bottle, and the mixture should be shaken about every five hours. Solution takes place completely in about two days. In the meantime, procure a sheet of plate glass. A disused mirror will serve for this purpose. The glass should be stiff enough not to bend under the weight of the subsequent treatment. Now roughly level the glass and pour the solution on the centre; gradually cover the plate by pouring in a spiral outwards. The solution, if of the strength stated, should be a thin cream. On the wet surface now place some disused inverted gas-mantle holders, or some of the copper-asbestos rings used for exhaust pipes. Rings up to three inches in diameter can be used if later treated with care. The rings should have a ground face rubbed on them if they are not quite flat. The plate and its load of rings and holders may now be left to dry.

Thinnest Known Substance.

When thoroughly dry, which will not be for a day or so, place the plate in a shallow dish, level it and gently pour water into the dish until it comes up to the level of the top face of the rings. After an hour the water will, by capillary action, creep in between the glass and the celluloid film, detaching the latter. (Incidentally, the water will also separate the silvering of the mirror from the back, so be careful to use only an old disused mirror.) If the films appear to be obstinate, a penknife may be gently thrust under the edge at one or two places so as to allow the water to start its action. The process must be done very gently, as we are dealing with films of the order of one forty-thousandth of an inch in thickness. In Fig. 3 are shown the rings placed on the mirror and standing upon a levelled tripod. The nearest ring has three lugs soldered to it. It was used as part of a novel form of microphone of the condenser type patented for wireless purposes. In the foreground is shown one of these condenser-plates with its lugs turned down to form a little table. It is a "black" film, i.e., the thinnest known substance, but it is supporting a twenty-gram weight. In the background are some of the completed condensers. In Fig. 4 the same plate with its cargo is being detached by the water. The gas-mantle holder on the right shows the water partly across the film. The others have been completely lifted.

When the films are safely lifted, a sharp knife may be used to trim the edges. The result when dry will be a series of beautiful films like soap-bubbles. Some years ago there appeared an article in a non-technical

journal regarding the wonders of the "permanent soap-bubble." These are the identical films. They are, of course, permanent so long as no person breaks them! Although these films are so thin that no measuring instrument can determine their thickness, the last illustration shows that they are remarkably strong. It is also possible to measure their thickness by their colour. Owing to the colours produced by the interference of the light waves, and also because the wave-lengths of the light waves have already been determined by processes too lengthy to be entered into here, the range of colours obtainable by these films varies in accordance with their thickness. The thinnest film is the black film and corresponds to about one hundred-thousandth of an inch.

Practical Uses.

A word here as to the uses of these interesting novelties may not be out of place. As far as the writer is aware no other person has used these films for the purpose of making variable condensers of the type which vary their capacity with the modulations of sound. The writer took out provisional protection in the early part of this year for an electrostatic trans-

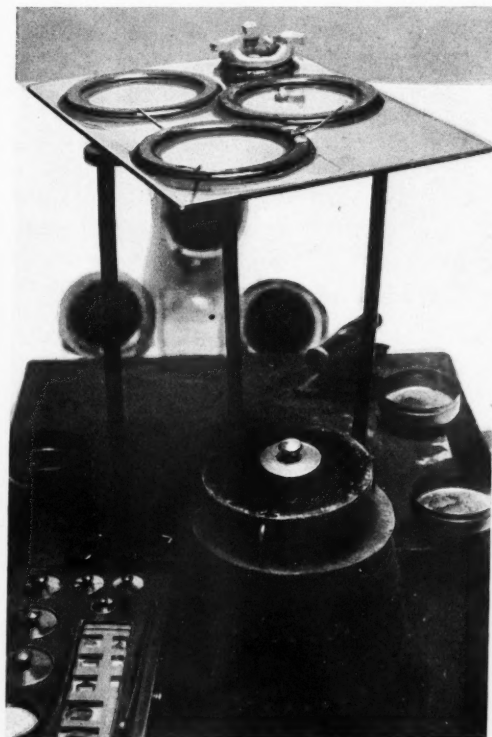


FIG. 3.
THE RINGS SETTING ON A LEVELLED MIRROR.

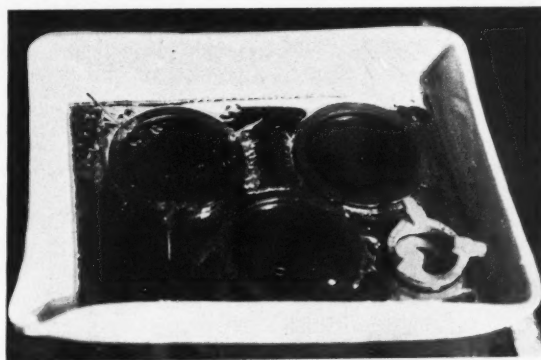


FIG. 4.
WASHING OFF THE RINGS.

mitter on this principle, but owing to lack of capital the project was dropped. The road is therefore now clear to any other experimenter. There is, of course, a multitude of microphones operated on the capacity principle, but there is no master patent, and the majority of the ideas published depend on brass plates, gold leaves, and other indelicate devices. These films are used by Thorp in his exquisite diffraction gratings; they have been used by Glew also for similar wonderful devices. It is understood that he has succeeded in lifting a black film ten centimetres in diameter! Readers will no doubt shortly realize what a feat of delicate touch this was. However, lest anyone should be discouraged, let me hasten to say that a film on the ordinary gas-mantle holder is quite easy to raise, and in that form they are very useful in chemical research as membranes for separating dissolved salts in a colloidal solution. This may be tested by pouring a salty gelatine solution into such a film resting on the surface of a tumbler full of water.

AN ELEMENTAL FERTILIZER.

EXPERIMENTS carried out by the French Government show that pure sulphur as flowers of sulphur has an unexpectedly large value as a fertilizer for such crops as potatoes, tomatoes and turnips. A hectare planted with tomatoes and fertilized with 199 kilograms of sulphur in addition to the ordinary fertilizer, gave an increase yield 1,300 kg. The yield of potatoes was similarly increased by 15 per cent, and turnips by 30 per cent. One of the advantages of sulphur is that it corrects any excessive alkalinity in the soil; according to the authorities who carried out these experiments it also increases the starch content of potatoes and promotes a vigorous foliation.

Synaesthesia, or Hearing Colour.

By Dr. Eric Ponder.

Are you one of those people who see sound as colour? It is a far more common attribute than is generally known, and in some cases sound is associated with co-sensations of smell. Very little is known about these interesting phenomena.

Most people are not aware that a great many perfectly normal persons will admit, if tactfully questioned, to being the possessors of certain peculiarities associated with their faculties of vision, hearing, taste or smell. These peculiarities are grouped under the name of synaesthesiae or co-sensations, and are characterized by there being an association between two senses: for example, between the sense of sight and that of hearing, so that the sound of a voice, a note, or an instrument, produces an urgent sensation, not only of sound, but also of colour; or between hearing and smell, so that sounds produce in the person affected a quite unmistakable sensation of the presence of an odour.

The ordinary man can scarcely grasp the idea of such a co-sensation as colour hearing, and usually looks on anyone who asks him if he "ever hears in colours" as either a buffoon or an idiot; if told that a great proportion of normal people associate sound and colour, he merely retorts that he declines to believe that a great proportion of the human race are insane. Anyone, however, who is himself a colour hearer at once understands the nature of the question, and is invariably eager to discuss the matter, and to explain his peculiarities to someone who will not ridicule his ideas, although he would never dream of introducing the subject himself, for fear of being put down as mentally unbalanced. Indeed, so anxious are colour hearers to talk about their experiences to anyone who is interested, that one has to be very much on one's guard against those whose anxiety to make themselves interesting obscures their sense of truth.

Idea Associations.

Synaesthesiae are in no sense abnormalities, as one might at first sight think. To begin with, sensations—even peculiar sensations—possessed by over sixty per cent of educated people, cannot be called abnormal. Further, although these co-sensations are most frequently met with in highly-sensitive and often highly-talented individuals—perhaps because they are more inclined to talk about them—they also occur in stolid, very ordinary folk, whom no one could accuse of being unstable or unduly imaginative. We meet with

co-sensations in most children, and also in savage races in all parts of the world. Nor are they mere associations of ideas: if, for example, I meet a person who tells me that the notes of a piano sound black and white, or that the note of a trumpet gives him the idea of yellow, or the taste of an apple the sensation of green, I am in no way surprised, for it is very natural to associate green with apples, yellow with brass, and the notes of a piano with black and white.

Co-sensations.

Only to-day a patient told me that arsenic always gave him a strong sensation of violet, but such an idea originates merely from the fact that the most usual form of arsenic tonic, which he told me he had taken as a child, is made up with lavender water. The association of violet with the taste of arsenic could not, for this reason, be called a true co-sensation; it is merely an association of ideas, like the apples and greenness. But when a person tells me that Schumann's piano concerto in A minor is blue mixed with waves of red—I give actual cases, not imaginary ones—that the number three, the diphthong *ei*, and the letter *k*, are yellow, or that the usual musical expressions *adagio*, *sostenuto*, *allegro*, etc., ought to be done away with and replaced by their appropriate colours, I realize that the speaker possesses true co-sensations, for it is not possible, except in a very strained manner, to attribute such ideas—so intensely felt that the possessors become angry if told, for instance, that *ei* is not yellow but green—to mere association of ideas.

In general, the most common form of co-sensation is that of colour hearing, or audition colorée. This may be met with in many forms, and in all degrees, ranging from a mere association, often lost during adolescence, between sounds and colours, to a condition in which the colour sensations are so vivid as to pervade the whole emotional life of the person affected, and to be to him a source of the greatest enjoyment. There is no better way of giving the reader an idea of the phenomena than to quote a few illustrative cases.

In the commonest form, frequent in children, the sound of the vowels or even of the consonants of the alphabet produce a sensation of colour. As a child,

an acquaintance of mine considered that *a* was red, *e* yellow, *i* blue, *o* a very dark blue, and *u* a reddish-brown. The sound of the vowels in ordinary speech did not give rise to these colour sensations, as the general sound of the words obscured the individual sounds, but if my friend shut his eyes and pronounced the vowels, he at once had a vivid sensation of colour. Bleuler and Lehmann made an investigation of the relation of colour sensations to vowel sounds, and found that there was a great diversity of opinion among colour hearers on the question, but that in general *i* was blue, *a* blue or black, and *e* yellow. Their investigation also brought out what appears to be a very general fact, that green is a colour avoided by colour hearers—an avoidance which appears in other psychological processes, as shown by the fact that people rarely imagine green ghosts or see green in dreams, and that those highly-gifted folk who perceive around each man and animal their proper aura, hold that a green aura is a most undesirable one, no animal possessing it except the cat, and no person except those who are evilly disposed towards the seer. An excellent example of coloration of vowels is given in the sonnet by Rumbaud, the first line of which runs,

"A noir, E blanc, I rouge, U vert, O blue,
voyelles. . ."

—a clear case of an association of colour with sound in which, be it noted, the colour green appears.

Street Noises.

Other simple sounds, such as the red squeak of a slate pencil, the yellow of a whistle, and so on, also produce colour co-sensations in certain people. One of the most famous cases is Heine's "triumphant red of the trumpet's note." I know of several colour hearers who find that the hoots of taxi-cabs are associated with colour sensations, and who display great interest in these sounds when walking in the street.

The sensations aroused by these simple sounds may be extended to a coloration of the notes of the scale, as in one of my cases who says that C is white, D yellow, E bright yellow, F brown, G colourless, A pink and B a rich purple, and whose entire musical taste is influenced by these associations. Since he dislikes the colour yellow, he also dislikes any passage written in E, and tells me that he is greatly relieved when the adagio of the Moonlight Sonata changes to the allegro, "which is a deeper and more satisfying colour."

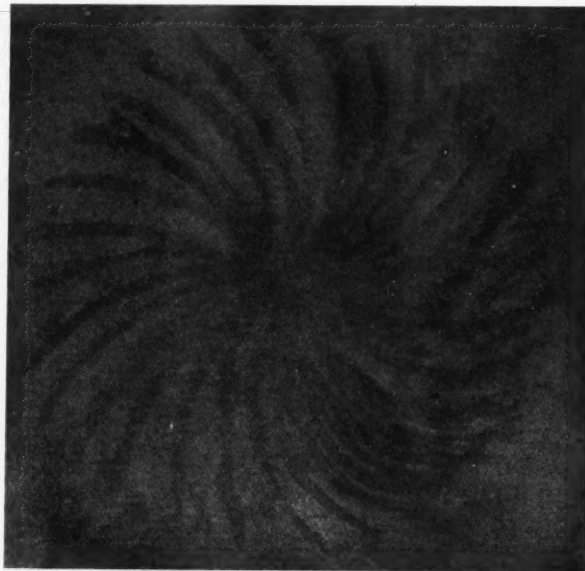
Complex Effects.

This colouring of the vowels or other simple sounds is a very real matter to the person who experiences

it, and often leads to disagreeableness and, in children, to quarrels. I have often seen a colour-hearer angry when told by another colour-hearer that a certain vowel was yellow, for instance, when he thought it was red. Nussbaumer says that he used to quarrel bitterly with his brother about the colours produced by the rattling of spoons and forks together, for they could not agree regarding their colour associations.

More complicated cases involve the colouring, often in a vivid manner, of chords, musical pieces, poems, scenes accompanied by music, and the like.

To E. Hoffmann we owe the following: "I was wearing a coat which I had bought in a great ill-humour over the failure of a trio, and whose colour was in C flat minor: I therefore, to mollify the beholders, put on a collar in E major." Again, the poet Ganghofer writes, "When I listen to Rheingold there always comes an instant when the whole stage is filled for several seconds with an intense golden yellow. If I play the first movement of the first trio of Haydn with my children, the music sheet towards the end becomes a dull red violet, which as we pass without a break into the adagio cantabile, changes to a deep steel blue." An artist friend of my own offered to give me a rough colour study of Tchaikowsky's Chanson



A NEUTRAL-TINTED COLOUR-HEARER'S IDEA OF WAGNER'S
"RIDE OF THE VALKYRIES."

This object fills his field of vision when the music is played, especially if his eyes are shut. It rotates clockwise at great speed.

Triste. He commenced to work up a background of brown, and then proceeded to cover it with reddish spots, but soon abandoned the effort for, he explained, he could not get the colour right. At this failure he was most annoyed at himself, besides being very apologetic to me. This fastidiousness in the matter of colour is very common in colour hearers, and is well illustrated by Galton's case, who gave the following very exact description of the vowel *e*, "red, not transparent: vermilion with china white would represent it," and of *o*, "black, but transparent, the colour of deep sea water seen through thick clear ice."

A Colour Organ.

There is little point in elaborating examples but, in considering the extent to which these co-sensations can go, we may note that there was some years ago a serious suggestion to erect a colour-organ, whereby music would be automatically concerted into colours on a screen, for the benefit of colour hearers. The project was never carried to completion, and very fortunately, for we may be sure that little pleasure would have resulted therefrom, as colour hearers do not as a rule agree in their colour interpretations; it would have been exasperating for Mr. A to see Mr. B's blue setting of his favourite red sonata. I myself knew, some years ago, of a medical student of considerable musical ability, who constructed above his piano a frame bearing coloured glasses, and an apparatus which, when complete, was to produce the music played in its proper colours. This gentleman believed that the notes of the scale corresponded to the colours of the spectrum, there being seven notes and seven colours. His colour-piano was never completed.

Colour co-sensations remain very constant in the individual; they may increase or decrease in intensity, but do not alter appreciably in character. A child, for example, who thinks that *e* is red never changes his idea of the colour of *e*, and says, at a later date, that *e* is yellow. He may, of course, if sufficiently laughed at, deny that *e* has any colour at all, or he may, in course of time, lose his co-sensation altogether. Parents often behave in a very foolish way with children who show signs of colour hearing, treating them, from sheer ignorance, as if they were addicted to some bad habit—a great mistake, as the child is caused to elaborate his ideas in secret. If he does this, and has a tendency to audition colorée, we have inclination and imagination added to predisposition and, as a result, a marked accentuation of the peculiarity.

While it is usual for sounds to give rise to colour sensations, the reverse may in rare cases take place, and colours may give rise to auditory sensations.

We all know that artists speak of brightly-coloured paintings as being "in a high key" and to sombre shades as being "low-pitched." These expressions may be looked upon as mere figures of speech, but the nature of the figure indicates that somewhere in the mind of the speakers the association of pitch and colour must have a place. I do not know, however, of any well-marked case in which the sight of colour gave rise to a sensation of hearing, in the absence of the reverse effect.

The reader may not know that a great many folk have a very defective colour memory: they visualize a scene—a garden of flowers, or such a familiar scene as their own dinner table—as if it were uncoloured, and seen as in a black-and-white photograph. This defect of visual memory may go so far as to prevent them being able to "call up in their mind's eye" any idea of colour at all. Such people practically never have audition colorée, but some of them have a peculiar form of it in which, being unable to visualize colour at all, they have, on the hearing of sounds, a series of sensations of black and white or of grey, usually not very intense in nature. I have met with several cases of this "neutral-tinted colour hearing" and have some crayon sketches of the impressions produced on one gentleman by the playing of a certain piece of music—a collection of radiating spokes of a dark colour on a lighter background. This extraordinary object, he says, occupies his field of vision whenever he hears Wagner's "Ride of the Valkyries" played, and especially if he shuts his eyes. The sensation which he gets is entirely uncoloured; were it not for this he would be called a typical colour hearer. This particular form of co-sensation is said to arise out of the more usual form as the individual grows up and loses, as most people do more or less, his visual memory.

Hearing a Smell.

Although colour hearing is the commonest co-sensation, it is by no means the only one or the least interesting, for we have co-sensations involving other special senses, such as associations between hearing and smell, or hearing and taste, or even between common sensation, such as that of touch, and a special sense.

To take first co-sensations of sight and taste, we may mention Hilbert's case of a lady who had the sensation of yellow when she drank good milk, and of blue when she tasted anything sweet; she classified unpleasant tastes as brown, and very unpleasant ones as green. The same gentleman who told me that arsenic is violet tells me that certain ciders taste

green, and became very irritable when I disputed the point—a sign that a true co-sensation was present. His mother tells me that she “well knows the green taste and the purple one; the green one is not pleasant, but the purple one is horrible.” We may note that a tendency to experience co-sensations often runs in families: the brother of this gentleman shows well-marked colour hearing. Lohmann tells of a man who saw blue when he smelt a woman’s hair, and of another who said that lemons tasted yellow, but as a rule such taste co-sensations are rare, probably because they have been little investigated.

Hoffmann—the same who put on a collar in E major—speaks of co-sensations of smell and sound. He writes, “I find a harmony of colour, music and odour. . . . The odour of a dark red carnation has a marvellous effect on me. . . . I hear as though from the distance the notes of the basset horn swelling and again sinking.” An apparently perfectly normal lady told me that all music she heard was associated with smell: the Lohengrin prelude she said smelt of roses, the odour becoming overpowering as the music swells up in the horn passages at the end; Beethoven’s minuet in G, No. 2, gave her a powerful sensation of ripe apples; Verdi’s “Caro Nome” smelt of carnations, and any ‘cello music of cloves. Indeed, her appreciation of music practically amounted to an appreciation of smell.

Examples of co-sensations of sound and taste are very rare. The only one of which I know occurs in one of my colleagues who, as a child, used to complain to his mother that the running of a water-tap spoiled the taste of his dinner. It is, nevertheless, generally known that epicures object to the playing of music while they are eating, and one gentleman tells me that this is because the music dulls the sense of appreciation of flavour. The sense of taste, however, appears to be a rather degenerate one, and not much affected by co-sensations.

Generalized Co-sensations.

Co-sensations of types other than those which we have mentioned are almost unknown, and the few cases described are open to some doubt; we shall therefore pass them over, merely mentioning Lohmann’s case of the man who saw red when pricked with a needle.

Many people, however, combine various co-sensations into a kind of generalized co-sensation, usually provoked by music. One of my friends tells me that when he hears the adagio of Beethoven’s Hammerklavier sonata he feels as if he were being stroked with down, while he sees at the same time opposite

him a flaming surface of golden yellow, which gives out a gentle warmth. This he enjoys intensely; he is unable to obtain the sensation with any other piece of music, although he would like to do so.

Such conditions are merely elaborations of the simple synaesthesiae, and are quite common among those who have marked associations of colour and sound, colour and smell, or other co-sensations. The more elaborate the associations become, the more the pleasure which they give the person affected, who may even use them as an inspiration for artistic or musical works. Flornoy tells of one artist who based his pictures on the notes of his violin; I myself know of a lady who sits and paints while music is being played, saying that the sounds help her with her colour.

Field for Inquiry.

Nothing is known as to the origin of these extraordinary phenomena. They are clearly psychical in origin, and not based on any abnormality of the senses themselves, for examination of persons affected usually shows that the powers of sight, hearing, etc., are perfectly normal. Colour hearing and the other co-sensations never seem to be acquired, but usually exist from early childhood, although they may be developed to a great extent in after life. In view of the very emotional character of the experiences, frequent attempts have been made to explain them as being merely associations of ideas formed in childhood. A grown-up associates the ideas of apples and red—naturally, we say: but experience of children shows that a child may associate, equally naturally, the ideas of apples and brown—because, for instance, a little girl of the name of Brown used to accompany him on illicit apple-eating expeditions. The reason for the association may be lost in later life, but the association remains, and appears as a sensation of brown when the individual eats an apple. Whether associations of this kind play a part in the explanation or not, the co-sensations are very sharply marked off from mere associations, a fact which is apt to be overlooked, for it is an essential of a co-sensation that the person affected shall not only have an association of two ideas, such as a sound and a sight, but that he shall actually have a sensation of seeing something when he hears a sound. The association may be easy to explain, but the projection of the feeling of the person outside himself, as it were, in the form of a sensation, is more difficult to understand.

To put it in a very loose way, it appears that in a certain type of person, usually one whose visual and colour memory is very acute, a kind of overflow

of sensation takes place from one sense to another. Sensations of sound overflow, and manifest themselves as sensations of colour, the leak occurring because of the intense effect produced on the emotions by the sound sensation, which effect is relieved, as it were, by a simultaneous visual sensation, just as the sensations produced by tickling are relieved by wriggling and laughing. The sense into which the leak takes place is the one which of all the senses in man is the most active and complex, the sense of sight, as we have already noticed, for we have seen that co-sensations not involving this sense are very uncommon.

AWARD TO PROFESSOR C. V. BOYS, F.R.S.

THE Duddell Medal of the Physical Society has been awarded to Professor C. V. Boys, F.R.S. When presenting the medal the President of the society said:

"Professor Boys is one of the oldest Fellows of the Physical Society, and in the early history of the society he took a most active part. He has been Demonstrator, Secretary and President of this society. The Duddell Medal is essentially an award for producing apparatus to advance science, and Professor Boys is renowned not only for his knowledge of physics, but for his exceptional constructive ability. He invented the first method for producing quartz fibres; indeed, it was he who first had the idea of making fibres of very small diameter and freedom from elastic fatigue; he made a most beautiful torsion balance for measuring the constant of gravitation; he invented the radiomicrometer—that beautifully sensitive instrument which will measure the heat radiated from a candle at a distance of three miles; he it was who first photographed a bullet in flight, and afterwards showed us how to blow soap bubbles and study the thin films of which they are formed. A little more than a year ago he exhibited a most beautiful calorimeter, and in the future I feel sure he will produce many other beautiful and valuable instruments. All his apparatus is characterized by exceptional beauty of design—as an experimenter he is unexcelled. It is with the greatest pleasure that I make on behalf of the society the presentation of the Duddell Medal to Professor Boys."

Professor Boys, after expressing appreciation of the award, made some remarks as to the ideals he had kept before him in the design of apparatus. It was comparatively easy to increase the sensibility of instruments, if one had no objection to multiplying the experimental errors by a corresponding factor,

Whatever the explanation of their nature, these phenomena are of the greatest interest in themselves, and their investigation, even if it provides us with no clue as to their cause, at least gives us an insight into some of the many peculiarities of mankind. Moreover, little technical knowledge or skill is required in order to investigate their outstanding characteristics, and—a rare thing in science—material is plentiful and cheap, for anyone who takes a little trouble can find, even within a small circle of acquaintances, persons who will both possess co-sensations and welcome inquiries about them.

but he had always made it his aim to attain the highest sensibility while keeping down such errors. Unless such precautions were taken the strangest phenomena might be observed with highly sensitive apparatus—in consequence, for instance, of convection current disturbances.

THE "DISCOVERY" EXPEDITION.

THE "Discovery" will proceed to the Falkland Islands in time for the whaling season of 1925. A base has in the meantime been established at Grytuiken, South Georgia. Three zoologists and a hydrologist will be attached to the expedition. The appointments at the Marine Station are:—Zoologist in charge, N. A. Mackintosh, B.Sc., A.R.C.A., J. F. G. Wheeler, B.Sc., L. H. Matthews, B.A.; Hydrologist, A. T. Clowes, B.Sc., A.R.C.S.

The scientific personnel of the expedition itself is:—S. W. Kemp, Sc.D., Director of Research, A. C. Hardy, M.A., J. E. Hamilton, M.Sc., E. R. Ginther, B.A., Zoologists; H. F. P. Herdman, M.Sc., Hydrologist. Several learned societies and government departments are represented on the executive committee in charge of the undertaking.

POISON GASES TO KILL THE BOLL WEEVIL.

THE cold spell that was experienced in the cotton belt of America last January has had the effect of reducing the activity and damage done by the boll weevil to under 25 per cent of the normal destruction this pest causes. Experiments are now to be carried out by surrounding the winter retreats of the boll weevil (woodlands and so on) with heavy poison gases that have many times the penetrating power of the most severe cold snap the winter could produce.

An Ore-locating Instrument.

This describes a new instrument which enables subterranean ore bodies or oil reserves to be mapped with precision.

UNTIL quite recently the work of prospecting for mineral deposits situated beneath the earth's surface was limited to boring and other similar methods, which not only furnished very scanty and to some extent uncertain information, but were also very costly and tedious.

A number of methods, employing various scientific principles, have recently been adapted to the location of these deposits, the most successful and important of which is that based on an analysis of the gravity conditions at any point.

This method is based on the well-known physical property of mass attraction, which is a force capable of acting through great distances. All masses or bodies are known to attract each other with forces whose magnitudes in any particular instance depend on the density and size of the masses, and the distances between them. These individual forces give a total force for every point on or in the earth, which together with the centrifugal force due to the earth's rotation, constitute the force of gravity. In consequence, the force of gravity varies in regions in which there are bodies of different density. It is interesting to note that compared with the average density of the rocks forming the earth's crust, useful minerals are in general either considerably heavier or lighter and, although the disturbance of gravity due to their presence is exceptionally minute, it has been found possible to construct an instrument which is able to detect these variations, and by this means it becomes possible to deduce the magnitude and depth of the disturbing body and so to put these measurements to a useful purpose.

This instrument, which is known as the Eötvös Gravity Torsion Balance, is based on the following simple arrangement. Variations of gravity are measured by the amount of twist in a very thin torsion wire, which carries a light beam supporting a gold weight on one end, while from the other is suspended a second gold weight. Great care is taken to protect the instrument from temperature variations, and under these conditions it is exceedingly sensitive and accurate. It is well known that gravity is a little greater at the poles than at the equator, due to the shape of the earth, but this change of gravity takes place gradually over this distance, which is approximately six thousand miles. The Eötvös Balance,

however, is so extraordinarily sensitive that it is easily able to measure the difference in gravity which would occur between two points situated only one centimetre apart in this direction.

Recently the instrument has been applied with success to the location of various deposits of ores, salt, and the like, while its use in the search for oil has become most extensive. The smaller density of mineral salts compared with inert rocks causes a modification in the gravitational field in the locality of such deposits, while in the case of ores the increased density has a corresponding effect. In consequence it is possible to locate the edges of such deposits with considerable accuracy, while geological faults and anticlines can in general be fixed by means of the balance.

Improved Eötvös Balance.

The "Oertling" model recently produced in this country, although essentially the same as the original Eötvös instrument, possesses a number of special and improved features. Hitherto the visual method of observation by means of telescopes has entailed the provision of long arms to carry them, so that a large and heavy tent was necessary. Moreover, to read the instrument, the observer must enter the tent each hour, and thus risk temperature variations reaching the instrument. In the modern instrument telescope arms are completely eliminated, so that a much smaller tent may be used. The very small twist of the torsion wire is recorded photographically by means of a special optical system, which enables an increased and variable sensitivity to be obtained. After the instrument is once set up at a station it is manipulated entirely by clockwork, which causes exposures to be made at the end of each hour and the instrument to be rotated into a new position. If desirable it can be used visually even although it is not fitted with telescopes. An image of a scale is thrown on to a ground glass screen and may be observed from a distance; advantage is taken of this fact to provide it with a special small cylindrical tent, fitted with observation windows through which readings are made from the outside. After observations are completed at one station the instrument is clamped to the tent, and the complete equipment moved bodily to the next station without dismantling either the instrument or the tent.

In order that the balance may be protected adequately from temperature variations it is provided with three metal walls, while the tent has also an equal number, the entire wall spaces being packed with special insulating materials.

Television, or Seeing by Wireless.

By John L. Baird.

The author has recently demonstrated successful—if rudimentary—vision by wireless. His system is simple and represents a very marked advance in principle. It does not involve the use of prepared photographs, but allows the observer at the receiving end to see what the instrument at the transmitting end is "looking at." The invention is still in a very crude state but is of considerable interest.

THE subject of television is often confused with the sending of photographs by wire or by wireless. This is perhaps a readily understood confusion. Television, however, is quite distinct from photography. It is the instantaneous transmission of the living and moving object so that the person at the receiver may actually see and watch the movements of the person at the transmitter or, if the transmitter is directed at a scene, such as a racecourse, the spectators at the receiver may actually see the race at the moment it is occurring.

Past.

Very many attempts have been made to solve the problem of television, one of the first devices, the "Telectroscope" of Senlec dating as far back as 1872; yet, while telephony and telegraphy have made vast strides since those days, television for many years remained, as far as practical results were concerned, at a complete standstill. Nevertheless, a great number of schemes were put forward as attempts to solve the problem.

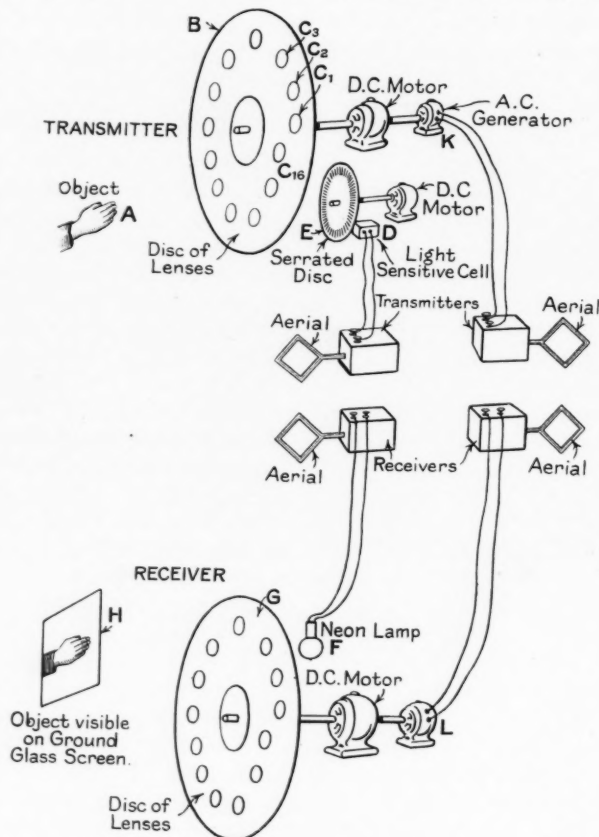
The theory is simple. The image of the object to be transmitted is broken up into a great number of little areas, each area having its own value of light or shade, and signals are sent along the line corresponding

to the light intensity and position of each area, so that a similar mosaic is built up at the receiver, the complete operation being performed many times per second so

that a kinematograph effect is produced. Although, however, the theory is simple, the practice is exceedingly difficult owing to the immense speed of signalling involved.

Present.

In my system the object to be transmitted (A) is focussed by each of the lenses C 1, etc. in the disc B on to the light-sensitive cell D. The lenses are arranged in a spiral or in a staggered formation and, as the disc revolves, each lens causes a single strip of the image to traverse the cell. Before reaching the cell the light is interrupted at high frequency by the serrated disc E. This interrupted light causes a pulsating



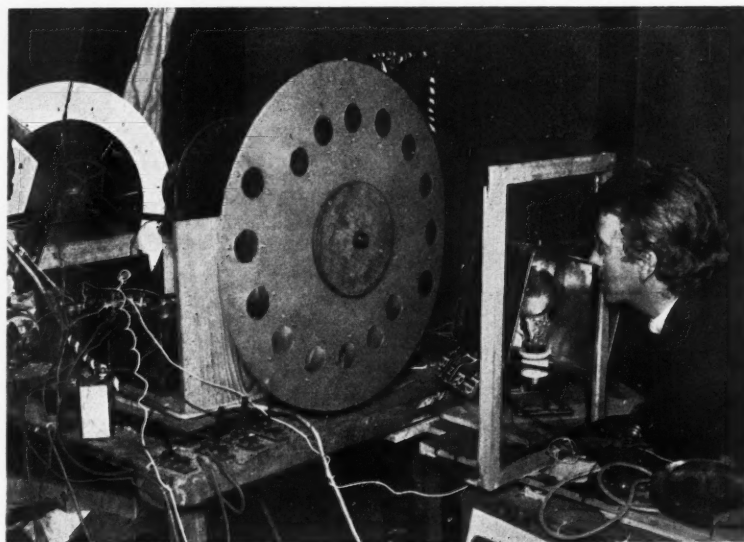
current to flow through the cell circuit, and this current is transmitted to the receiving station where it lights the lamp F behind the disc G which is similar to the transmitting disc B. As these discs revolve in synchronism the varying light from F traverses the screen H and reproduces the image.

Isochronism is obtained by coupling an alternating current generator K to the transmitter and sending

an a.c. current from there to the receiver where, after amplification, it controls the speed of the alternating-current synchronous motor L. Synchronism is simply and effectively obtained by rotating the driving mechanism about the spindle of the receiving machine until the image comes correctly into view.

The present models, which are purely experimental, are capable of transmitting only coarse images. Simple objects such as letters of the alphabet are perfectly clear. The hand appears only as a blurred outline, the human face only as a white oval with dark patches for the eyes and mouth. The mouth, however, can be clearly discerned opening and closing, and it is possible to detect a wink.

So many prophecies and promises have been made with regard to this subject. I shall add no more to their number, but certainly it can be said that we are now actually "seeing by wireless"—very crude and very imperfect vision, but a man even with acute myopia and astigmatism is not called blind.



THE TRANSMITTER OF THE BAIRD TELEVISION APPARATUS,
showing the lens disc and the interrupter.

NOTE BY THE EDITOR OF *DISCOVERY*.

I attended a demonstration of Mr. Baird's apparatus and was very favourably impressed with the results. His machinery is, however, astonishingly crude, and the apparatus in general is built out of derelict odds and ends. The optical system is composed of lenses out of bicycle lamps. The framework is an unimpressive erection of old sugar boxes, and the electrical wiring a nightmare cobweb of improvisations. The outstanding miracle is that he has been able to produce any result at all with the very indifferent material at his disposal.

The invention has now reached a stage when it should be properly developed and an adequate instrument built. In its present form it reminds one of some of the earliest rudimentary attempts to produce

a cinematograph. These were then looked on as scientific novelties of no practical value, but have since developed into an enormous industry. Mr. Baird is anxious to secure adequate financial backing for the development of the invention, and it is possible that the importance of the invention may appeal to some big industrial concern interested in its possibilities.

The apparatus has now been moved from the original workshop at 22, Frith Street, and erected at Selfridges where visitors may see demonstrations.

Whether this particular invention or some other inventor's system will eventually develop into a commercial success is, however, not the main point.

The outstanding fact remains that rudimentary transmission of visual images by wireless is now possible and that it is only a question of time, refinement and improvement before we reach the point where reception screens will be normally attached to wireless receiving apparatus and we shall see the speakers whose words we hear. Already we have been

in wireless communication with an exploring expedition somewhere in the depths of South America. In the not too distant future we may expect not the rather wearying "travel talk" from a broadcasting station, but direct wireless speech and vision transmitted from the ends of the earth and relayed to our firesides. We shall see on our screens the reproduction of distant events and hear them explained as they take place.

It is a devastating outlook, for eventually it will probably be applied to the ordinary telephone service and prevarication will be even more difficult than it is to-day. On the other hand, when it arrives, we shall find so many conveniences in it that we shall wonder how we ever got on without it in the past.

Civilizing the Indians of Brazil.

By Charles W. Domville-Fife.

(Late Correspondent of The Times in South America; Author of "The Real South America," "Among Wild Tribes of the Amazon," etc.).

On the banks of the great South American rivers and in the dense surrounding forests dwell many Indian tribes whose existence is virtually unknown to the outside world. The author describes some of these races and their manners and customs, and also the work the Brazilian Indian Protection Service is doing in uplifting them and bringing them under control.

ALTHOUGH the existence of the Amazon has been known for upwards of three centuries, it is only within recent years that we have learned something of the manners and customs of the strange Indian tribes who dwell in its vast primeval forests. The very name of the river is derived from the mistaken conception of the sex of one of these races, the Yahuas.

When Francisco de Orellana, in 1540, sailed down the Rio Napo, which joins the Solimes, the main stream of the Amazon, just beyond Iquitos, he was consistently attacked by a band of savages who, because they wore their hair long and were dressed in capes and skirts of grass, were taken for women warriors, and so the name Amazon was given to the great river. But the Yahuas who attacked the daring Portuguese adventurer were not women, but men; and it is still the custom of this strange tribe for the men to wear their hair long and to clothe themselves in grass skirts. Probably then, as to-day with so many of the wild tribes I have encountered, it is the men who elect to clothe themselves while their women go virtually naked.

According to the officials of the Brazilian Indian Protection Service, there are nearly three hundred distinct tribes of Indians dwelling in the Brazilian forests that line the banks of the Amazon and its innumerable tributaries, ranging in degree of development all the way from the most primitive savages to a civilization that almost equals that of the ancient

Incas. They certainly represent a most interesting and even fascinating study to the ethnologist. Indeed, one could spend a whole lifetime studying them. Although most of these races speak different dialects

they have much in common, their vocabulary being very limited—a matter of a few hundred words or so in some cases. They live principally by cultivating the mandioca plant, by fishing, and by the chase, their weapons being the spear, blow-pipe, or an obsolete form of firearm.

One of the most interesting tribes of these savages which I have encountered is that of the Itogapuks, a distinctly different race from most savages to be found in the Amazon regions. Although both men and women live

day and night in a state of nudity under the communal roofs, there was no sign of indecency or of the loathsome diseases only too apparent in other settlements. When I first came across this tribe two young Itogapuk girls of about fourteen, after circling curiously round me for some time, eventually plucked up courage for a closer examination. First my clothes and then my hands were scrutinized in perfect silence and wonderment. Not satisfied with this, they rolled up my sleeves, spat on my arms, and rubbed them vigorously with their hands! Evidently they expected the white to come off and see me revealed in my true colours. When nothing happened, however, they tried further investigations at the open neck of my shirt; but, having been spat



HUITOTA GIRLS PAINTING THEMSELVES BEFORE A DANCE.

upon once, I gently though firmly resisted any further scientific tests, distracting their attention by allowing them to listen to the ticking of my watch. Curiously enough, it was during my first night with this savage tribe that I encountered the vampire bat. The air was very still, and the night intensely hot. Under the mosquito-netting it seemed difficult to breathe, and within a few minutes of turning in everything was wet through with perspiration. This, combined with the croaking of hundreds of frogs in the nearby swamp and the buzz of innumerable insects, kept me awake for hours.

sleep it was impossible to say—and my ankles were so swollen from the bites of mosquitoes that I could not get on my marching-boots, and had to content myself with a pair of soft leather mosquito boots, which I had hitherto kept specially for ease and comfort during the evenings.

Doubtful Cannibalism.

It would be misleading to say that this tribe of savages appears to have cannibalistic tendencies. In the absence of definite proof it should be assumed otherwise, because cannibalism, in the fullest sense



SEMI-CIVILIZED FOREST INDIANS PREPARING TAPIOCA.

Being very tired and restless, I must have kicked the mosquito-netting away from my feet while dozing. Anyhow, just before dawn I awoke, and felt a curious, cool, tickling sensation in one of my feet.

Vampires.

Using the little electric torch reserved for emergencies, I flashed on the rays suddenly, and a large vampire bat was flapping his webbed wings while sucking the blood from a wound made in my left foot. Blinded by the light, this loathsome creature flew out of the mosquito-netting and then circled away into the starry dawn.

Rearranging the mosquito-netting, I examined the foot and found a small but deep incision on the instep from which blood was dripping. Next morning I felt very weak—whether this was due to loss of blood or

of the word, has so far not been proved against any tribe of the great Amazon forest. There is, however, little doubt that they are anthropophagi; and the evidence lies in their custom of drinking a cupful of the blood of certain animals killed in the belief that by so doing they gain the strength, cunning, and intelligence of their victims. In this respect they are similar to the Cashibos of the Ucayali, and the Uaupes of the Uaupes river, who grind up the bones of enemies killed in battle, mix the powder into a thin paste with the fermented juice of fruit, and drink it to secure the strength or sagacity of the deceased but admired foe. If the conquered one is weak, cowardly, or falls an easy victim, then the head is cut off as a trophy, and the trunk thrown into the forest or used as bait for big game. It would seem

that the women do not participate in these cannibal rites; but of this or of cannibalism being widely prevalent among these tribes I have no evidence, and am of the opinion that it is a mistaken belief.

A much fiercer tribe than the Itogapuks are the Parintintins of the Gy-Parana. Very foolishly I had made my way right into the heart of a Parintintin village, by means of presents which I gave them in order to pacify their savage instincts. I saw quite clearly, after two or three days, that my life and the lives of my two boys depended upon the daily distribution of presents, many of which would have been useless to the Indians in the absence of anyone to show them how to make use of them. One day I refused to give any more, mainly because there was little left, even of my original stock of food and clothes. The temper of the tribe changed from that moment, and in genuine alarm I promised a big distribution if they would carry my tent and heavier packages back to the canoe. To this, however, they would not at first agree, asking me to remain with them and to use my rifle in battle.

This gave me the opportunity I sought. Packed away in a valise I had a small 22-bore sporting-gun with detachable butt. Telling them that if they conveyed my packages back to the canoe I would give them a "stick-that-spoke" eventually so aroused the cupidity of the chief that they assented. My relief was great, and that night I divided the few important items of my kit and packed them in my ruck-sack, together with some food and medicines.

In Trouble.

On the following morning, true to their word, at least half the tribe followed us into the jungle on the way back to the river. I noticed that beyond a small package of food my two canoe-boys were carrying nothing. From that moment I knew that only strong action would get us down the river alive. When we were about what I judged to be half-way, the chief, a wrinkled old warrior, asked me to show him the "stick-that-spoke." This I flatly refused to do, saying that all sticks spoke in my hands, whereupon he scornfully picked up a rotting branch and handed it to me. Feeling for my revolver, I fired through the pocket of my jacket while holding the twig in my opposite hand. This simple manoeuvre so impressed the Parintintins that, although several of them scowled at me and drew back their bows, nothing more was said until we reached the river and the canoe.

When the brushwood with which the canoe had been covered was removed and all was ready to depart, I slipped the shot-gun out of the valise and handed

it to the chief. Even after six days of intercourse the suspicious old Indian would not take it from my hand, but motioned me to show him how to use it. This I did in front of a half-menacing line of savages, but took care to leave only sporting cartridges, from which I had extracted the powder and bullets during the previous night. Getting into the canoe, I kept my revolver ready, and it was lucky I did so, because scarcely had the paddles dipped in the river before a shower of poisoned arrows splashed into the water around, and one stuck, quivering, into the woodwork of the canoe.

Poisoned Arrows.

It was a ticklish moment. Seized with panic, Mosquito—the name given to my boy on account of his thin legs—plied his paddle vigorously, while the other boy seemed paralysed with fear. The result was that the canoe curved out into the stream, instead of moving away from the Indians, who could not follow along the forest-encumbered bank. I fired three shots into the bush behind which these treacherous Indians had taken shelter; and whether it was the reports that broke the spell or the kick I gave cannot be said, but the next moment the canoe shot away down-stream, propelled by the two thoroughly-scared boys. For nearly two hours they paddled hard, causing the small craft to skim over the dark, placid surface, on which were mirrored the million leaves of the forest walls.

These savage races of the Amazon have always proved a vexed problem to the Government. As civilization advances it is desirable, of course, to bring them under control. This means the establishment of some sort of administration over vast areas of forest—a no light task.

In order to check raiding rubber gatherers and prevent an iniquitous form of exploitation and enslavement of the natives by them, the Indian Protection Service was established by the Brazilian Government in 1910. It has worked wonders in the forests.

Attraction Posts.

The officers of this organization are ever pushing their way into the primeval forest, establishing "attraction posts" and doing everything possible to get in touch with the wilder tribes of the forests and win their confidence and friendship. One of their first achievements was the pacification of the Kaniganis, who inhabit the hinterland of Sao Paulo. This tribe, one of the most fierce in Brazil, had on many occasions attacked the gangs of workmen engaged in the con-

struction of the North-Western or Brazil Railway. And this is how the pacification was accomplished.

A picada, or rough path, was opened through the virgin forest as far as the River Feis, on the banks of which "attraction posts" were established and stocked with objects both useful and ornamental, such as would be likely to arouse the curiosity or cupidity of a primitive people. Little by little suspicion and defiance yield to these attractions, and finally the Indians arrived in groups, bringing presents and provisions for the camp at Ribeirao dos Patos, where

mission and the presence of more useful gifts closer in towards the camp. In many cases months would elapse before the curiously timid yet nevertheless fierce natives appeared within view of the camp.

Peaceful Advances.

Hundreds of presents were stolen during the hours of darkness; but no reprisals were made, only messages were left stating that there was no necessity for secrecy when approaching the gift-tree, as what they held were merely samples of the white man's



A COMPLETELY CIVILIZED FAMILY WITH THEIR HOUSE.

Kanigani interpreters from the Parana region succeeded in convincing them of the friendliness of the white men.

In other camps along the borders of the unknown land tall hollow trees were fitted with steps and a crow's-nest built at the highest point. From this elevation, towards evening, interpreters cried aloud through the stillness of the forest messages of peace and amity. Another device employed in the huge forest state of Matto Grosso, among the savage Rhambiquaras, Parexis, Iranches, and other tribes, was to cut lanes through the undergrowth leading to the camp of the Protection Service, and every half-mile or so along these well-defined trails to hang presents on the trees together with messages in native characters explaining the object of the white man's

work offered to the Indian in return for friendship and trust.

So remarkably successful were these methods that, within a year from the establishment of the posts, these same Indians were employed in guarding the long overland telegraph line connecting Matto Grosso with the Amazonian waterways. Had the erection of this line been commenced before the friendly intentions of the Brazilian pioneers had been definitely established, a hundred military posts would not have prevented these wild tribes of the almost impenetrable forest from destroying it as fast as it was put up, and many of the white engineers and their transport columns would inevitably have fallen victims to the silent but peculiarly deadly poisoned dart.

The Plant, the Soil and the Climate.

By J. Riley, B.Sc.

The new tools with which the scientist attacks unsolved problems concerning agriculture are wonderful instruments. The agricultural chemist is gradually being provided with a special armoury for his campaign.

FEW people realize the romantic story that is being unfolded by the patient work of those who are engaged in making the comparatively new science of agriculture. The importance of the work will be admitted by everyone. But there are few who would not be astonished by a visit to an agricultural laboratory. Agriculture is by no means the simple science that it was thought to be only a very few years ago. Many of us probably still retain the idea that the chief thing that science can do in relation to the cultivation of the soil is to discover artificial fertilizers—chemical manures that can be put into the ground to feed the growing crop and increase the yield. This was indeed the first stage in the development of agricultural science. In the early days, chief attention was paid to the fertility of the soil, and this was regarded as being mainly a matter of the chemical food which it contained. A fertile soil was one rich in food for the plant, especially in nitrogen. In so far as this food was natural, it was simply the accumulation of the residues of ages of natural vegetation, and the ground lost its fertility as this residue became exhausted, unless, of course, chemical manures were supplied to make the loss good.

Agricultural science at the present day is far more complex. The instruments and apparatus that form the equipment of an agricultural laboratory nowadays have been designed to investigate a great variety of problems that have come to light as a result of the second stage in the growth of the science—in which a serious attempt has been made to find out all the factors that play a part in affecting the growth of various kinds of crops.

The New Science of Agriculture.

The trend of the new science of agriculture can be put in a nutshell by stating that it regards agriculture as being concerned with three inseparable factors—the plant, the soil, and the climate. Only by considering these three together can we arrive at a complete solution to any practical problem. It is impossible to obtain a reliable conclusion by considering any one of them separately, as was frequently done in the early days.

An illuminating example of this important fact was given by Sir E. J. Russell, F.R.S., in his presidential

address to the Agricultural Section of the British Association in Toronto last year. He pointed out that soils in different parts of the world, exactly similar in type, may vary greatly in fertility if there are differences in climate. Thus the lias clay in Oxfordshire is similar to the soil in certain parts of the Sudan. In Oxfordshire this soil is very difficult to cultivate and the land is waste, whereas in the Sudan the soil is fertile and is utilized successfully in the cultivation of millet and cotton. The reason is not difficult to find. Clay holds moisture, and if the rainfall is too great, the amount of water retained by a clayey soil asphyxiates the plant roots. The Sudan climate is dry, and in such circumstances a moisture-holding soil is a considerable advantage. Again, a sandy soil is waste land in Norfolk, where the rainfall is low. But in Anglesey, where the rainfall is greater, a similar sandy soil can still retain sufficient moisture to enable it to be successfully utilized for market gardening.

Soil and Climate.

It is the combination of these two factors of soil and climate in relation to the growth of the plant that is our special concern in this article, and we are desirous of pointing out the means by which these factors are being studied in our present-day laboratories. For those who are unable to visit an up-to-date laboratory, a glance through a catalogue of apparatus for the examination of soil, such as that issued by Messrs. Gallenkamp & Co., Ltd., is a revelation of the ingenuity of those who are grappling with the problems of soil and climate in connexion with plant cultivation. The most important work upon this subject in this country is, of course, that carried on at the Rothamsted Experimental Station, and most of the special apparatus in Messrs. Gallenkamps' list has been designed by experimenters at this station, and made by them for use at Rothamsted.

A Recording Balance.

One of the most wonderful appliances in the agricultural laboratory is the automatic and continuous-recording balance. The most elaborate form of this instrument is known as the Odén-Keen Automatic Balance, developed by Dr. B. A. Keen and staff of the

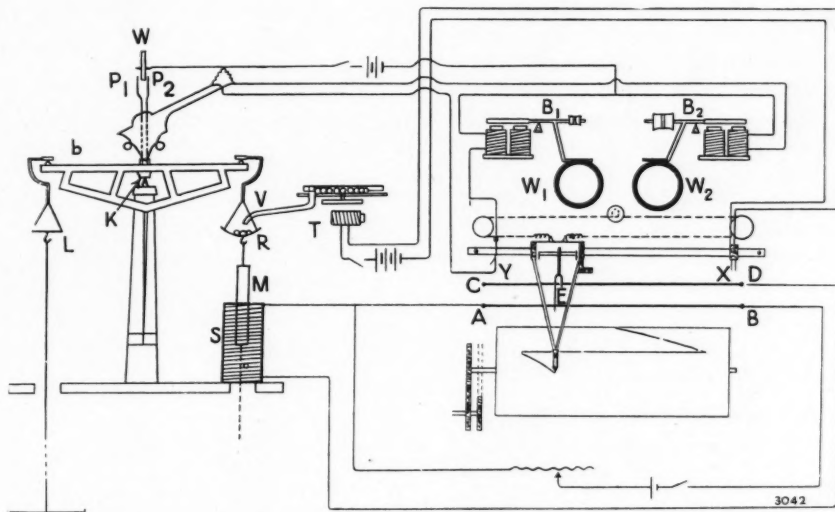
Soil Physics Department, Rothamsted, and Professor Sven Odén, of Upsala University, Stockholm. It is manufactured by Messrs. Gallenkamp, and has already been used by the Cotton Research Board, Egypt, the Union of South Africa, and other bodies, for the determination of size distribution in soil and other suspensions, the flocculation of colloids such as clay, and the rate of evaporation of water from various materials.

All these subjects need to be studied in connexion with the problems of the soil. The size of the particles of the soil influences its capacity for holding moisture, as well as its lifting power due to its capillary, or

irrigation schemes for the artificial watering of the soil has been realized in those regions where the local rainfall has been insufficient for purposes of cultivation. In connexion with all irrigation schemes the problem of economy must always be considered, because by this means it is possible to irrigate larger areas.

Use of the Balance.

The automatic recording balance plays a very necessary part in solving such problems as these. In the illustration we are shown diagrammatically the principles according to which the balance operates. It will be seen that a balance beam *b* is supported by



THIS DIAGRAM SHOWS THE PRINCIPLES UPON WHICH THE ODÉN-KEEN BALANCE OPERATES.

wick-like, action. The moistness of soil is a very important factor in promoting the growth of the plant, and this depends very largely upon the size of the soil particles, together with the climatic conditions.

Function of Colloids.

The colloids, or gum-like constituents, of the soil also play an exceedingly important part in connexion with its fertility. The generally accepted view is that the colloids in the soil exert a steadying effect which counteracts the acidity that might otherwise be produced by the formation of acids in the soil.

Lastly, the rate of evaporation from the surface of the ground is a still further factor that influences the moisture remaining in the soil. This is a matter that must be considered very carefully in those parts of the world where water supply is a matter of difficulty. From the very earliest times the importance of

means of agate knife edges on an agate plate *K*. From the left arm of this beam a pan *L* is suspended, which hangs below the base of the balance-case in the enclosure which contains the material under experiment. The weight of the pan and its contents is balanced by means of the right-hand pan *R* (and the weights upon it) and also by the force of the current in the solenoid *S* upon the small cylindrical magnet *M* which hangs freely in the centre of the solenoid. The current in the solenoid is not constant, but is adjusted so as to keep the balance in equilibrium, by an automatic movement of the sliding contact *E* along the two wires *AB* and *CD*.

Suppose there is a slight increase in weight in the pan *L*. The beam of the balance will be displaced. In consequence, the insulated platinum prong *P2*, which is fixed to the balance beam, makes contact with a rotating wheel *W*. This completes a subsidiary

relay circuit which controls a clockwork mechanism which moves the contact E to the right. In consequence of this movement, the current through the solenoid S, and therefore the force on the magnet M, is increased until the balance returns to the position of equilibrium.

As the weight on L continues to increase, the contact E thus moves along the slide wires until it reaches a pre-arranged position X. At this point, an insulated projection on E presses two metal tongues into contact. This closes another relay circuit, the function of which is to place upon the scale-pan R a ball from the ball-dropping mechanism T. As a consequence of this increased weight on the right-hand pan, the platinum prong P_1 is brought into contact with the wheel W; and a relay circuit and clockwork mechanism, similar to that connected with prong P_2 , comes into action to bring the slider E back to its starting position Y, when the cycle of operations recommences.

The whole apparatus is a triumph of scientific invention, and is a tribute to the determination and ingenuity of those who are investigating soil problems. The recording arm is attached to the sliding contact E. By the use of this balance the weight of the contents of the scale-pan attached to L is recorded automatically and any gradual alteration is registered with absolute accuracy.

Other Soil Instruments.

Among other instruments for investigating the properties of the soil must be mentioned the centrifuge machines which are used so largely by the U.S. Bureau of Soils in clarifying suspensions, and in separating "colloidal" clay from samples of soil. These machines—popularly called "whizzers"—are capable of generating centrifugal force many thousand times that of gravity. There are also "colorimeters" for measuring the rate of absorption of dyes by soil and for turbidity measurements; constant volume bottles for measuring soil shrinkage under various conditions; sieves for the mechanical analysis of soil; and electrical apparatus for determining the acidity or alkalinity of soil, either of which if excessive will produce far-reaching changes in soil properties. Further apparatus deals with the chemical analysis of soil.

Soil Meteorology.

Finally we may refer to the instruments by means of which the problems of soil meteorology are investigated. These include the familiar rain-gauge—the latest type of which is self-registering; the soil temperature recording thermometer, which also keeps its own records automatically; and the recording

hygrometer. This instrument is based on De Saussures' hygrometer, in which the expansion and contraction of a hair are used to measure the changing degrees of atmospheric moisture. In this particular instrument, the hairs number no less than fifteen, and they are specially selected and treated to remove fatty substances.

Transformation of Solar Energy.

We may take the sunshine recorder as our last illustration of the way in which the new agricultural science may be expected to assist the practical agriculturist. Sir E. J. Russell has pointed out that at present plants utilize only a minute fraction of the energy that they receive from the sun. Experiments have been carried out by F. C. Gregory at Rothamsted to measure what this fraction actually is. This is not an easy thing to do; but the results obtained show that the most efficient plant falls far short of our worst motor-cars as a transformer of energy. A modern motor engine transforms thirty per cent of the heat of combustion into mechanical energy. But our best field crops convert no more than one per cent of the heat of sunlight into stored-up chemical energy. If only we could increase this to the efficiency of the modern motor-car we should obtain four hundred bushels of wheat per acre from an ordinary crop.

The problem is being attacked from a number of sides. V. H. Blackman has already obtained increases in plant growth of from twenty to twenty-five per cent by the action of high-tension electrical discharge, while attempts are being made to increase the rate of plant growth by increasing the percentage of carbon dioxide in the atmosphere.

It is clear that the new agricultural science is only at the beginning of a period of development that may be productive of the most astounding and gratifying practical results. In this article we have been able to deal only with one or two aspects of the subject, but enough has been said to show the thoroughness of the methods of those who are intent upon tackling this complex problem and rendering more productive the soil upon which we are so dependent.

COLOURED OYSTERS.

RECENT research shows that the green colour of French oysters is due to a pigment present in the food materials. The experiments involved the isolation of the pigment from a quantity of *Naviculæ*, and it was shown that oysters placed in a sea-water infusion of the colouring matter took up the colour in twenty-four hours.

Elastic Glass.

The legend of elastic glass drinking vessels supplied to a Roman emperor is a very old one, and as dubious as it is old. This new invention, which is not yet commercially perfected, may have important applications.

Two Austrian chemists, Dr. Fritz Pollak and Dr. Kurz Ripper, have now succeeded, after years of patient experiments, in producing an organic substance which is practically elastic glass. This material, which has been named "pollopas," consists of carbomide and formaldehyde and strongly resembles flint glass in its outward appearance. It differs from glass inasmuch as it is purely organic, leaving no ash if consumed by fire. Thus it is the representative of a class of substances never yet synthetically produced, *i.e.*, that of organic colloids, this being an expression used by chemists for bodies which show no inclination to crystallize. Products of this kind have only of late years been made the subject of more intensive investigation, seeing that they are less easily purified and, therefore, harder to examine scientifically than crystalloids. The name "poll-opas" was chosen because the new material is similar to the opal, inasmuch as it is "irreversible," which means that it cannot be dissolved in water once it has been chemically dried. The great difficulty which faced the inventors in this case was not so much the necessity of producing a colourless and pliable substance as that of making it completely transparent, uniform and immaculate. The present product possesses these qualities and has a degree of hardness corresponding more or less to the third degree of Mohs's scale, a degree hitherto represented by chalk-spar. It can be just as easily worked on a turner's lathe as other materials used in turnery, but is eminently softer than glass and can also be filed, beaded, bored, polished, planed, coloured and macerated. It resists heat without burning up to a temperature of about 280 degrees centigrade, while at a higher temperature it chars. It likewise resists all sorts of solvents including diluted acids and alkalis. It has about half the weight of window glass.

Advantages over Ordinary Glass.

It is distinguished, moreover, by a number of valuable qualities. In the first place, it permits the passage of ultra-violet rays, or the chemically valuable rays of the sun, to an even greater degree than flint glass. This fact is of especial importance in the construction of hospitals and sanatoria, notably for tuberculous patients, who have hitherto been obliged,

even in winter, to expose themselves to the open air when absorbing the beneficent ultra-violet rays. The same fact holds good for the construction of hot-houses, as it is again the ultra-violet rays which are most efficacious in promoting the growth of plants.

Besides being softer than glass, "pollopas" is also far more elastic; indeed, it is one of the most elastic substances hitherto discovered. Thus it is most eminently suitable for automobile panes, receptacles for the preservation of dry substances, and protective goggles for workmen and tourists. The relatively low specific gravity of "pollopas" makes it most suitable for the manufacture of travelling requisites, toys, fountain-pen holders, and handles of all descriptions. There is also no reason why it should not be advantageously used for trinkets, smoking requisites and knick-knacks. Curiously enough, the substance, though completely colourless and transparent, may be distinguished from glass without much difficulty by reason of its shorter spectrum.

Further Possible Uses.

Another advantage of "pollopas" over glass is that it can be easily dyed according to scientific standards, that is to say, with dyes adjusted to definite wavelengths, a fact of no small importance in the production of coloured photographs and for optical and biological purposes. Finally, it is apparent that solutions of "pollopas" prior to its precipitation may very well furnish excellent binding or stiffening materials. As a matter of fact, it has been proved that such solutions, which can well be preserved, will lastingly and indissolubly bind paper, glass, wood, metal or any other substance and are indeed unrivalled for the repair of broken glass and porcelain goods. The solutions can also be used for lacquering purposes, presenting the aspect of enamel. Pictures or photographs, moreover, can very advantageously be covered with a thin coating of "pollopas" to protect them against damp or other outside influences. The coating produced by "pollopas" solutions is so thin that it may even be employed as a means of impregnating cloth. Treated with this solution, a soft cotton tissue will acquire the character of a strong and durable linen and, what is more, will retain it after washing.

The amount of rigidity attained will depend on the quantity of the solution used. For imparting a certain stiffness to materials long in use, to felt hats, etc., such a solution is invaluable.

For the purpose of ornamenting cloth, silk or other textiles with patterns, the use of "pollopos" is remarkably suitable. Whereas glass beads have hitherto had to be attached to the cloth by hand, "pollopos" need simply be dropped on the fabric in a liquid state and will immediately cleave firmly to it, whereby a considerable saving of time, labour and expense is involved. For printing on cloth "pollopos" can be employed more simply and efficaciously than other substances and has the advantage of defying the effects of time and weather. In both cases the simplicity and relative cheapness of the

process make it possible to apply a variety of patterns which could only be attained at the cost of considerable trouble and expense in other ways. It has also been found possible to use "pollopos" solutions as binding materials in connexion with printers' dyes and in the textile and paper industries, the absence of colour in these solutions proving a very valuable asset. A number of other technical uses may be expected to result from experiments and investigations at present in progress, so that no complete verdict can be passed as to the commercial value of the invention. Up to the present "pollopos" could be placed at the disposal of trade only in relatively small quantities, seeing that the manufacture of the new material on a larger scale will only be possible after the lapse of a few months.

Books Received.

- The Origin of Man.* By CARVETH READ. Second Edition revised and enlarged. (Cambridge University Press. 5s. net).
- Man and his Superstitions.* By CARVETH READ. Second Edition. (Cambridge University Press. 12s. 6d. net).
- Principles of Transmission in Telephony.* By M. P. WEINBACH, A.B., B.Sc. in E.E., A.M. (Macmillan & Co. 17s. net).
- The Teaching of Science.* By E. J. HOLMYARD, M.A., M.Sc., F.I.C. (G. Bell & Sons Ltd. 6d. net).
- A Handbook to the Freshwater Aquaria and Vivaria.* Third Edition rewritten. (London County Council. 3d.).
- A Handbook to the Cases Illustrating Stages in the Evolution of the Domestic Arts. Part I.* (London County Council. 3d.).
- Animals in the Making.* By J. A. DELL, M.Sc. (Victoria). (G. Bell & Sons Ltd. 2s. 6d.).
- Hints on Notemaking in Science and Mathematics.* By R. T. HUGHES, M.A. (G. Bell & Sons Ltd. 2s. 6d.).
- The Ideal Aim of Physical Science.* By E. W. HOBSON. (Cambridge University Press. 2s. net).
- The Theory of Quantitative Analysis.* By HENRY BASSETT, D.Sc., Ph.D. (Routledge & Sons. 15s. net).
- Quo Vadimus? Some Glimpses of the Future.* By E. E. FOURNIER D'ALBE, D.Sc. (Kegan Paul. 2s. 6d. net).
- Brown Heart in Australian Apple Shipments.* Food Investigation Board. Report No. 22. (H.M. Stationery Office. 1s. 3d. net).
- Electrical Engineering.* By L. A. HAZELTINE. (Macmillan & Co. 30s. net).
- Das Problem der Rechtshändigkeit.* Von DR. HANS KLÄHN. (Gebrüder Borntraeger. G.U. 4.50).
- The "Gas" Content and Ventilation of Refrigerated Holds carrying Apples.* Food Investigation Board. Report No. 21. (H.M. Stationery Office. 1s. 3d. net).
- History of the Telephone in the United Kingdom.* By F. G. C. BALDWIN, M.I.E.E. (Chapman & Hall. 42s. net).
- Biology.* By PROF. PATRICK GEDDES and PROF. J. ARTHUR THOMSON. (Williams & Norgate Ltd. 2s. 6d. net).
- The Internal Secretions.* By DR. ARTHUR WEIL. (G. Allen & Unwin Ltd. 18s. net).
- An Introduction to the Study of Recent Corals.* By SYDNEY J. HICKSON. (Longmans, Green & Co. 25s.).
- Egyptian Mummies.* By G. ELLIOT SMITH and WARREN R. DAWSON. (George Allen & Unwin Ltd. 25s. net).
- A Brief History of Civilization.* By JOHN S. HAYLAND, M.A. (Oxford University Press. 3s. 6d. net).
- Journal of the Marine Biological Association of the United Kingdom.* Vol. XIII. No. 3. March, 1925. (The Association. 6s. net).
- County Library Conference.* Nov. 4th to 6th, 1924. Report of the Proceedings. (The Carnegie United Kingdom Trust).
- The Subject Index to Periodicals.* 1921. K—Science and Technology. (The Library Association. £1 1s. net).
- Illustrations of the British Flora.* Drawn by W. H. FITCH, F.L.S. (Reeve & Co. Ltd. 12s. net).
- The Sociological Review.* Vol. XVII. No. 1. January, 1925. (Leplay House Press. 5s.).
- The Conquest of Cancer.* By H. W. S. WRIGHT, M.S., F.R.C.S. (Kegan Paul. 2s. 6d. net).
- The Geographical Journal.* Vol. LXV. No. 3. March, 1925. (Royal Geographical Society. 2s.).
- New Revelations in Astronomy and Gravitation.* By WM. HENRY PARKES. (2s.).
- Grundzüge der gesetzmäßigen Charakterentwicklung der Völker.* Von DR. S. PASSARGE. (Gebrüder Borntraeger. G.U. 5 and v.).
- The Upper Air Circulation of the Atlantic Ocean.* By E. W. BARLOW, B.Sc. (H.M. Stationery Office. 6d. net).
- The Bookmark.* First Number. Spring, 1925. (J. M. Dent & Sons Ltd. Published quarterly. Annual sub. 1s.).
- The Eleventh Annual Report of the Carnegie United Kingdom Trustees.*
- Charles Dickens and other Victorians.* By SIR ARTHUR QUILLER-ROUCH, M.A. (Cambridge University Press. 10s. 6d. net).
- The Story of Man's Mind.* By GEORGE HUMPHREY. (Routledge & Sons. 10s. 6d. net).
- Banstead: Three Lectures on its History.* By SIR HENRY LAMBERT, K.C.M.G., C.B. (Simpkin, Marshall, Hamilton, Kent & Co. Ltd.).
- Petroleum in Uganda.* By E. J. WAYLAND, M.Inst.M.M., A.R.C.Sc. (Lond.), F.G.S. (Geological Survey of Uganda. 5s. net).
- Fuel for Motor Transport.* Third Memorandum: Power Alcohol from Tuber and Root Crops in Great Britain. (H.M. Stationery Office. 9d. net).
- Plant Life on East Anglian Heaths.* By E. PICKWORTH FARROW, M.A., D.Sc. (Cambridge University Press. 7s. 6d. net).
- Relativity, Meaning and Motion.* By CLAUDE G. HENDERSON. (Watts & Co. 3s. 6d. net).

Book Reviews.

Human Origins: A Manual of Prehistory. By GEORGE GRANT MACCURDY, Ph.D. (New York and London: D. Appleton & Co. 1924.) Vol I.: "The Old Stone Age and the Dawn of Man and his Arts." Pp. xxxviii, 440. Vol II: "The New Stone Age and the Ages of Bronze and Iron." Pp. xiii, 516. (Price \$10.00).

To the layman the number of manuals of prehistoric archaeology which have been and continue to be produced must appear bewildering. Their existence is justified partly by the intricacy of the subject and the nature of the evidence, which allow ample opportunity for differences in interpretation and diversity of opinion; partly by the rapidity with which new discoveries add to our knowledge. In the present case, for instance, Dr. MacCurdy's chapter on "Fossil Man" has been rendered incomplete since publication by the discovery of the Taungs skull.

An adequate notice of the very complete compendium of prehistory by the learned director of the American School of Archaeology in France might well occupy more than a whole number of *Discovery*. It may without exaggeration be described as the most complete account of our present knowledge of prehistoric man from the earliest beginnings before he actually entered upon the phase of humanity, down to the time that he emerges into the light of history, that has yet been published. A careful examination of Dr. MacCurdy's lists of authorities and references reveals no important published source of information that has been overlooked, while the evidence has been carefully weighed and the conclusions tested in the light of Dr. MacCurdy's own observations on many of the sites described. Whatever may be the author's own views on any specific point, however, he is careful to give a hearing to opposing views, and in all cases his impartial account of the evidence will enable the student to use his own judgment.

Among the features which it may be worth while to mention as likely to be of particular value to the student, and especially the beginner, is the glossary of technical terms, the need for which is very real but is usually overlooked. The account of palaeolithic art in its various forms and stages of development is very full and particularly well illustrated. Indeed, the judgment shown in the choice of the very numerous illustrations throughout the book is deserving of high praise. In one matter, however, Dr. MacCurdy has earned the gratitude of all who are interested in archaeological research, and that is the list showing the stratigraphy and culture sequence of palaeolithic sites—a work of immense drudgery and invaluable. The repertory of palaeolithic art is second to this only in value and utility.

In a book of this character which covers the whole of the prehistoric period, the earlier phases of the Stone Age bulk largest both on account of their intrinsic importance and the greater interest they arouse; but it would be unfair to overlook the excellent accounts of the Bronze and Iron Ages, especially as these are not too well covered by general manuals of this character.

Dr. MacCurdy is to be congratulated on the successful completion of a lengthy task which, though a labour of love, was none the less arduous.

Lysistrata, or Woman's Future and Future Woman. By ANTHONY M. LUDOVICI. (Kegan Paul. 2s. 6d. net).

Can be depended on to induce indignation in 99.9953 per cent of women. At the same time this stimulus depends on the

aggravating or corrosive effect of a few grains of truth embedded in a mass of argument. These little books are very definitely pamphlets and meant for good hard-hitting polemics. "Lysistrata" is a very good half-crown's worth of counter-irritation to the acidities of the sterile feminist. It is old-fashioned and progressive at one and the same time. It is impossible to hold a brief for the whole of Mr. Ludovici's sexpertism, neither can it be condemned by anyone who has seen the ravages accomplished in the young mind by the extremists of the feminist cult. In general it can be taken as an extravaganza—a healthy challenging extravaganza in which facts usually suppressed or ignored by the old-fashioned feminist element are used very frankly. In pre-war days the book would have been a centre of discussion, and churches or (more important) horse-races would have been desecrated to prove its oneness. To-day we have, if we except old-fashioned girls' schools and the teaching element in general, got rather beyond Mr. Ludovici or his antagonists. It is an ageless theme—but it dates.

A History of Sculpture. By GEORGE HENRY CHASE and CHANDLER RATHFON POST. (Harper & Bros. 16s. net).

A book on sculpture dealing with all ages and all climes is a big task and it is perhaps too much to expect a book of reasonable proportions to cover thoroughly the ground, but for the authors or publisher to finish with the claim of a special section on the Orient is to whet the reader's appetite on a point upon which there is no hope of appeasement.

With such a title as "A History of Sculpture" there must be of necessity many dates and details which are inclined to prove rather heavy for the ordinary reader, however well handled, but to the serious student the arrangement of the volume with its introduction, the short summing-up and bibliographical note at the end of each period, concluding with a short glossary and index of sculptors and works should prove very useful. The point that seems a very serious omission in the earlier portion of the book, Egyptian to Roman, is that the author ignores absolutely the part played by the different types of architecture in the various periods, which were so very largely responsible for the manner in which the sculpture was treated by the artists—thus, as the massive Egyptian and Assyrian architecture gave place to the more elegant Greek and the less chaste Roman, so also the sculpture followed the character of the buildings it was to adorn and with which it was to harmonize. Without some consideration of the architecture of the period, a student will never get a true perspective of the ages when architecture and sculpture were so much more closely allied than they are to-day.

In these earlier chapters the one question that would seem to obsess the writer is not Was it right with its surroundings? but Was it more realistic than the previous age? Realism seems to be his criterion of virtue. To-day sculptors are more capable than ever before of producing realistic work. Are we, therefore, to assume that the sculpture now executed has never before been equalled? Note also how much space is given to the discussion of dreary groups like the "Laocoön" and the Farnese bull. The latter is actually described as a clever composition. Surely it is late in the day for such an idea to survive.

When, however, the reader reaches those chapters dealing with the Middle Ages, he finds the writing changes. The author feels and communicates to his reader the effect of the building

on the sculptor, and realism is no longer the writer's shibboleth.

† The illustrations in this section are also excellently chosen. At times, in other parts of the book, it is not the greatest work that receives the greatest prominence.

Upon reaching the moderns the student, if he knows anything of the British School, will feel there is considerable room for complaint. To take a few instances from amongst those who have passed on, no mention is made of Harry Bates, Armstead, Pomeroy, Colton, or Harvard Thomas. The last affected more sculptors than did the American who was dragged in on that pretext. Of those living the list of omissions is too long to give, but two may be given—Sir William Goscombe John and Sir Bertram MacKennal, and not one of the younger generation is mentioned when so many are worthy. A few other omissions that come to mind are, from Belgium the name of Rombaux, from France Auguste Cain, from Jugo-Slavia Rosandic.

A Brief History of Civilization. By JOHN S. HOYLAND, M.A. (Cantab). (Oxford University Press. 1925. Pp. 288. Price 3s. 6d. net. 7s. 6d. net best edition).

Great Peoples of the Ancient World. By D. M. VAUGHAN. (London: Longmans, Green & Co. 1925. Pp. x, 178. Price 3s. 6d.).

It is to be hoped that these two little books may receive the attention they deserve. The authors have carried out a task of extreme difficulty with conspicuous success. Small textbooks of this kind which survey the great periods of development in the history of civilization on broad lines and with a due regard to perspective are badly needed. A commendable feature in both volumes is the care shown in the selection of illustrations which are really significant and yet not hackneyed.

Egyptian Mummies. By G. ELLIOT SMITH and WARREN R. DAWSON, with woodcuts by A. HORACE GERRARD and K. LEIGH-PEMBERTON, and other illustrations. (London: George Allen & Unwin. 1924. Pp. 190. Price 25s. net).

Of all the strange customs and rites connected with the disposal of the dead among peoples whose beliefs are alien to the modern civilized world, mummification is perhaps the most familiar and the most readily comprehended. Its origin is obscure. The theory here accepted by Professor Elliot Smith and his colleague has everything in favour of its probability. The accidental preservation of the body in the hot sandy soil of Egypt strengthened the idea of the life after death, and gave rise to the desire to preserve the identity of personality and form, necessitating the employment of artificial means of preservation of the tissues when the change from inhumation to the custom of burial in a tomb prevented preservation by natural agencies. Professor Elliot Smith's experience in the examination of mummies has given him a position of unquestioned authority on the subject of the methods employed by the embalmers, and his account of the practices followed at different periods is a fascinating study, if a peculiar and, in its details, somewhat gruesome art. It is, however, a subject of no little importance in the history of civilization, for as Professor Elliot Smith rightly says, the group of ideas of which it formed part was responsible in large measure for the development of architecture and art in ancient Egypt. A chapter is devoted to the occurrence of disease among the ancient Egyptians as revealed by a study of their mummies. The book is very fully illustrated by some very carefully and skilfully executed woodcuts.

Bentham's Handbook of British Flora. Seventh Edition, Revised by A. B. RENDLE, M.A., F.R.S., Keeper of Botany, British Museum. (L. Reeve & Co. 12s. net).

Illustrations of the British Flora. By W. H. FITCH, F.L.S., and W. G. SMITH, F.L.S. (L. Reeve & Co. 12s. net).

These two books are complementary to one another, the "Illustrations" following in general arrangement the system adopted in the "Handbook." "Bentham and Hooker" is really far too well known to need any extensive review, for it is an established authority with sixty years of sustained popularity and seven successive editions behind it. The last previous edition, that of 1892, had become rather confused with later accretions of knowledge, and was beginning to show a certain indefinable flavour of age which was apparent more in the chapters on vegetable physiology and plant anatomy than in the keys or the classification.

The new edition and its accompanying volume, the "Illustrations," bring this fine old classic absolutely up to date. Doctor Rendle has had no easy task, for the limits to be set to certain species are not easy to define. The scientific botanist will, however, find the new Bentham thoroughly adequate for all purposes within its scope.

The student of botany or the general reader who requires a not too ponderous reference book for the identification of plants will find Bentham the best of books to work with. The keying is simple and with little elementary knowledge an unknown plant can be tracked down. Each is figured in the "Illustrations," and the number of the illustration appears after the name in the "Handbook." Reference and verification are thus made swift and easy.

The illustrations are necessarily on a small scale and not coloured, but the publishers have wisely remembered the old and memory-recording device so beloved of a vanished generation—that of colouring in the illustration oneself from a collected specimen. There are few better ways of learning, and they have therefore taken pains to print the illustrations on a paper which will take colours well. In this way the book becomes in the hands of a working botanist not only a guide and an index, but a record of personal fieldwork and pleasant memory to the individual.

E. P. G.

The Theory of Quantitative Analysis and its Practical Application. By HENRY BASSETT, D.Sc., Ph.D. (Routledge. 15s. net).

Chemistry has been defined as the science of weighing things, and it is true that sooner or later quantitative analysis is needed to solve problems or prove theories however up-to-the-minute the new work may be. The author has endeavoured to include in this volume not only a thoroughly systematic survey of the chemical laws and theories underlying the ordinary operations of analysis, but to co-ordinate them into a general scheme of practical experimental or laboratory work.

Starting with the easier examples suitable for advanced students, he expounds the theoretical points involved in the estimation. In this way the book proceeds with a clear discussion of the various steps. In a word, he has been successful in bringing a course of advanced quantitative analysis into a considered programme of modern chemical theory instead of leaving it as is all too often done as a purely rule-of-thumb business of applying methods without reasoning. A good book and likely to be of value not only to students but to post-graduate courses.

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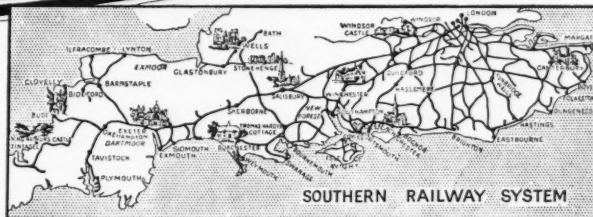
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Charles Dickens and other Victorians. By SIR ARTHUR QUILLER-COUCH, M.A. (Cambridge University Press. Price 10s. 6d. net).

How many undergraduates listening to these lectures in the crowded Arts Schools at Cambridge have been carried away by the eloquence of "Q." so far as neither to feel the hardness of the floor—for the women students always monopolise the seats—nor to remember how dull they find so many of the authors whom he praises.

He is no mere lecturer but the last of the orators, no cold critic but a very "gourmet" of literature. He and Sir James Barrie are surely the last of the Victorians. I do not mean that he is an indiscriminating enthusiast for things past, but that he possesses that gusto that is entirely lacking in modern literature.

"Consider, if you will, that literature, our mistress, is a goddess greater than any of us. She is Shakespeare and Ben Jonson too; Milton and Dryden; Swift, Addison, Steele; Berkeley and Goldsmith; Pope and John Gay; Johnson, Gibbon, Burke and Sheridan; Cowper and Burns; Blake and Wordsworth and Coleridge; Landor, Scott, Keats, Shelley and Byron; Carlyle, Ruskin, Tennyson, Browning; all, says the preacher, 'giving counsel by their understanding and declaring prophecies.'"

The relish with which these names fall from his tongue has been dead in literature for these last thirty years.

Here we have studies of Dickens, Thackeray, Disraeli, Mrs. Gaskell, Trollope and the Victorian background. "Q." is a personal critic; the personality of the author and the individuality of his characters is far more to him than the question of "style" that was so important to the nineties or that of "construction" that succeeded it, or the more mystical and psychological preoccupation of the present day.

"To-day"—he writes, "if I may diagnose your youthful sickness, you are occupied rather with lyricism, curious and recondite sensations, appositions of unrelated facts with magenta-coloured adjectives. The craze has spread to the shop-fronts, to curtains, bedspreads, as the craze for Byronic collars spread in its day: and 'Hell is empty!' cried Ferdinand, plunging overboard: but you can still find psycho-analysis rampant, with any amount of birth control among the geese in Golders Green."

He is unjust, but with a gesture that makes us, sitting in the Arts Schools or reading these reprinted lectures, fondly imagine for a minute that we can share his admiration for the great figures that seem to be almost incarnated in our lecturer and to forget that we probably shall never read Dickens and that the latest novel of Aldous Huxley, or the more serious effort of his brother Julian Huxley, lies on our table. J. M. C.

Physico-Chemical Evolution. By CHARLES E. GUYE. Translated by J. R. CLARKE, M.Sc. (Methuen & Co. 6s. net).

These three papers deal with the philosophical aspect of modern advances in science. The author finds in the application of Carnot's Principle a law of "statistical determinism" which though applicable to simple physico-chemical phenomena, fails to hold good when the more complex processes of living matter are considered.

The Rock Tombs of Meir. Part IV. *Archaeological Survey of Egypt.* By A. M. BLACKMAN. (Egypt Exploration Society, London, 1924. £2 2s.)

To the general public the most romantic figure in Egyptian archaeology is the excavator who at any moment may make

a discovery which will startle the world. Far less attention is paid to his equally useful and hard-working brother who, in place of digging up what is below the ground, occupies himself with recording and copying what is above it. It might, indeed, even be said that the latter is the more valuable to archaeology, for what is still buried will keep, in Egypt at least, indefinitely, so long as the law is strong enough and honest enough to prevent illicit digging by and on behalf of antiquity dealers, but what is on the surface is perishing from day to day and the priceless historical records which it contains are perishing with it. Among those who have set themselves to remedy so far as possible this state of things Dr. Blackman is one of the best known and the most efficient. Long practice has taught him to record faithfully and artistically the charming scenes which cover the walls of Egyptian temples and tombs, and, what is equally or even more important, he has by long years of hard study made himself master of the ancient Egyptian language.

His fourth volume of the Rock Tombs of Meir contains a full description of the tomb of Pepi'onkh, a feudal lord of the fourteenth nome of Upper Egypt and high-priest of Hathor during the reign of King Pepi II of the sixth dynasty. The volume begins with a list of the various titles borne by this noble, a list which would make some modern politicians green with envy. To the Egyptologist such a list emphasizes the fact that we still know almost nothing about the administration of ancient Egypt, for many of these titles are quite meaningless to us. To the philologist the most interesting thing in the book is the difficult biographical inscription, over which the author has taken endless trouble. But if anyone doubts whether this kind of work is worth doing and whether this particular tomb was worth saving from destruction and oblivion let him turn to the plates at the end of the book. Here he will find in admirably drawn scenes an almost complete epitome of the life—and death—of an Egyptian nobleman of 2500 B.C. In one plate Pepi'onkh, accompanied by his wife, is spearing fish, balanced on a frail papyrus-reed canoe in the marshes. In the next scene he watches his servants drawing in a great fishing-net or trapping wild geese and afterwards plucking and cooking them. Now we see the noble and his wife sitting at meat, while servants bring food offerings of every kind and two harpers and a flute-player amuse them with music; under the master's chair crouches his favourite dog. Another scene shows us ploughing, sowing and reaping, herding cattle and journeying by ship. In short, had this tomb alone survived we could still have drawn a remarkably vivid and accurate picture of life in ancient Egypt. What would we not give for one such tomb in Crete?

The Egyptological world will be grateful to Dr. Blackman for an excellent piece of salvage work, while the layman who wishes to know what Egypt was like in the sixth dynasty could not do better than consult the plates and text of this volume.

T. ERIC PEET.

Outlines of General Zoology. By HORATIO HACKETT NEWMAN, Professor of Zoology in the University of Chicago. (Macmillan & Co., New York. 16s. net).

A good general class-book for elementary instruction. The scope of the work is expanded so as to cover in general terms the elements of genetics and some reference to adaptation. It contains a lengthy explanation and defence of the modern evolutionary theory as against literal acceptance of the Biblical tradition. This, which would be entirely out of date in a European work of this nature, is, however, still a point of vigorous conflict in the New World.

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